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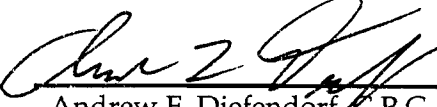
WORKPLAN FOR
SUPPLEMENTAL INVESTIGATION OF
NATURAL ATTENUATION OF
DISSOLVED CONSTITUENTS IN GROUNDWATER

PREPARED FOR
L.E. CARPENTER AND COMPANY
WHARTON, NEW JERSEY
USEPA ID #NJ002168748

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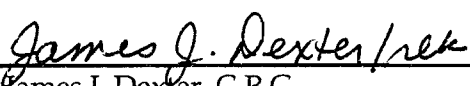

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Section 1

Background

The L.E. Carpenter site is located at 170 North Main St., Borough of Wharton, Morris County, New Jersey (see Figure 1). The site history has been summarized in numerous reports including, but not limited to, the 1992 *Final Supplemental Remedial Investigation Addendum Report* (Weston, 1992a), the *Evaluation of Remediation of Groundwater by Natural Attenuation Report* (RMT, 2000a), the agency approved workplan for *Further Off-Site Groundwater Investigation at MW19/Hot Spot 1* (RMT, 2000c), and is summarized briefly here.

The site had an operating iron mine and forge from the late 1800's to the early 1900's. Subsequently, the site was operated as a manufacturing facility for vinyl wall coverings from 1943 to 1987, and primarily as a warehouse (eastern portion of the site only) since 1987. An Administrative Consent Order (ACO) was entered into with the NJDEP in 1982, followed by a 1983 Addendum, and a 1986 additional ACO.

A site map is presented as Figure 2. Site remediation activities began in 1982, and have included, but are not limited to, the removal of 4,000 cubic yards of sludge and soil from the former surface impoundment, excavation and backfilling of the starch drying beds, the removal of aboveground and underground storage tanks and associated piping, the demolition and removal of various facility structures located on the eastern portion of the site, and the recovery of Light Non-Aqueous Phase Liquid (LNAPL or free product).

The original passive product recovery system installed in 1989 consisted of 3 selective-oil skimmer pumps (skimmers) and was upgraded to include a total of 8 skimmers in 1991. The free product recovery capabilities of the skimmer system were supplemented with manual bailing during third quarter 1995. In November of 1997, RMT installed a series of 28 recovery wells, and instituted monthly mobile enhanced fluid recovery (EFR). Between 1989 and 1997, a total of 4,229 gallons of free product were recorded as being recovered by means of product skimming and manual bailing. Through 1st quarter 2001, an additional 2,942 gallons of free product have been removed via EFR, bringing the total site free product recovery volume to an estimated 7,171 gallons to date. Free Product currently covers an area of approximately 100 feet by 600 feet, with variable thickness. An estimated 44,000 gallons of free product currently exist on-site, of which, approximately 8,000 to 13,000 gallons (20 to 30 percent) are considered recoverable (RMT, 2000b).

Conditions at the site with respect to free product and dissolved groundwater constituents have been summarized in on-going quarterly monitoring reports (e.g., see RMT, 2000d).

Groundwater in the vicinity of the free product zone contains three main constituents of concern that exceed NJDEP groundwater quality standards: ethylbenzene, xylenes, and diethylhexyl phthalate (DEHP) (NJDEP, 1994). Concentrations of up to several thousand micrograms/liter ($\mu\text{g/L}$) of these constituents are found in groundwater adjacent to the free product zone. However, concentrations decrease substantially over relatively short distances from the free product zone, such that, within 100 to 300 feet downgradient of the free product zone, concentrations are commonly nondetectable.

This pattern of substantial decreases in dissolved concentrations of constituents over relatively short distances indicates that natural attenuation may be occurring in the groundwater system. A May 2000 report prepared by RMT entitled Evaluation of Remediation of Groundwater by Natural Attenuation (RMT, 2000a) showed that the systematic decrease in constituent concentrations along groundwater flowpaths was occurring at the site, at a relatively rapid rate. Supplemental evidence of natural attenuation, in the form of chemical indicators such as low redox potential, low dissolved oxygen, high dissolved iron, and others, also supported the case for natural attenuation.

The NJDEP and the USEPA reviewed the May 2000 report on remediation by natural attenuation, and provided comments in June 2000. The agency review comments, and RMT's responses to these comments, are presented in the following section.

Section 2

Response to Agency Review Comments

2.1 Department's Comments

1. **Comment:** The Department is unclear what L.E. Carpenter is proposing, *i.e.*, whether it is natural attenuation of the free product, or natural attenuation of the dissolved portions of the plume with active recovery/treatment of the free product. According to the Technical Requirements for Site Remediation, N.J.A.C. 7:26E-6.1(d), natural attenuation of free and/or residual product is not permitted. The Department will consider natural attenuation of the dissolved portions of the plume provided L.E. Carpenter evaluate and implement more effective product recovery.

Response: Natural attenuation of contaminants dissolved in the groundwater, not free product, was evaluated for effectiveness as a remedy at the site. It is the intent of L.E. Carpenter to continue to implement, and to improve, recovery or destruction of free product at the site.

2. **Comment:** The model, its assumptions and applicability are acceptable, however its implementation is not. Incorrect sampling data was input into the Bioscreen model. Fourth quarter 1999 sampling results indicate 1600 ppb DEHP, not 670 ppb and indicated on Figure 6. DEHP is a persistent compound and this higher result may prove that natural attenuation is not a viable option for the dissolved portion of the plume. Also, sampling results for nearby MW-14s were not included in the modeling and delineation of both BTEX and DEHP is incomplete along the flowpath chosen for the modeling. Accordingly, L.E. Carpenter must correct these deficiencies before the Department will consider this proposal for natural attenuation of the dissolved portions of the plume.

Response: As the title on Figure 6 indicates, the results presented are for July 1999 (Third Quarter), not Fourth Quarter 1999. An exception to this is, as noted on the figure, that results for MW-22 are from April 1999, since MW-22 was not sampled for DEHP in July.

As discussed in Section 5 of the report, concentrations of constituents of concern have fluctuated seasonally over a wide range of values, but have decreased substantially since 1997 (see Figure 7c). While the Fourth Quarter 1999 concentration of DEHP (1,200 µg/L in MW-22, 1,600 µg/L in MW-22 duplicate) was somewhat higher than shown on Figure 6 for earlier in the year, that does not change the spatial pattern of DEHP significantly, which is the point of the figure. In fact, during the next sampling event, for Second Quarter of 2000,

the concentration of DEHP decreased substantially at MW-22, to 92 µg/L. These fluctuations in concentrations at individual monitoring points should be viewed over a longer period, to identify longer term trends. As illustrated on Figures 7a through 7c, concentrations show an overall decreasing trend since 1997. These observations support the conclusion that the groundwater plume is stable or decreasing over time, as discussed in Section 8.

Sampling results from MW-14S were not included in the modeling because there were no recent data for MW-14S. MW-14S is not part of the approved quarterly monitoring program for the site. However, we agree that current chemical data from MW-14S would be helpful in the analysis of natural attenuation. Therefore, we propose to supplement the existing site data with periodic sampling and analysis of groundwater from MW-14S, as outlined in Section 3.5 of this Workplan. These results will be included in the overall evaluation of natural attenuation of contaminants at the site.

3. **Comment:** Groundwater sample data at specific monitor well is referred to throughout the report, however no reference is made to the particular sample event that corresponds to the reported results. For example, on page 5-1 data is reported for monitor wells MW-14, MW-21, MW-22 and MW-25 without reference to a particular sample event.

Response: The discussion on page 5-1 refers to data presented on Figures 5 and 6, which are titled "Total BTEX in Groundwater (mg/L), July 1999" and DEHP in Groundwater (mg/L), July 1999. Generally, the report refers to specific results shown on figures on which the date of sampling is given, or refers to tables in which the sample dates are also given.

2.2 EPA's Comments

4. **Comment:** Natural attenuation data presented suggest that the aquifer within the LNAPL area has become anaerobic as a result of biodegradation. It seems likely that the aquifer was initially aerobic, but that oxygen and other electron acceptors have been depleted by biological activity. Currently, in the LNAPL area, very little degradation is likely occurring. However, as contaminants migrate out of the anaerobic area beneath the LNAPL, conditions become aerobic and degradation is likely to be active. Subsequently, the system can be conceptualized as active degradation on the perimeter of the plume, with little or no degradation in the area under the LNAPL.

Response: We agree with the conceptual model portrayed in this comment, with one clarification: In the last sentence of the comment, it states that the system can be conceptualized as active degradation on the perimeter of the plume. We would modify this

statement to say that active degradation is occurring *in the groundwater at the perimeter and downgradient of the free product plume.*

5. **Comment:** As a result of the above dynamics, the extent of the plume is likely partly controlled by the location of the aerobic-anaerobic boundary, and not solely by the actual flow of groundwater.

Response: We agree that the aerobic-anaerobic boundary will have a substantial effect on biodegradation rates, with increasing rates of biodegradation as the groundwater becomes less reducing/more oxidizing, downgradient of the free product.

6. **Comment:** The Bioscreen modeling presented in the report should be largely viewed as an academic exercise and not as an accurate representation of site conditions. First, the model assumes that degradation is occurring at a single rate along the flowpath. As noted above, degradation is likely occurring only at the fringe of the plume. Also, the inputs to the model are largely based on literature values and general assumptions, not on site specific characteristics.

Response: The Bioscreen modeling was used as a screening-level tool, to assess whether biodegradation of BTEX and DEHP was likely occurring at the site, warranting further delineation. This use is consistent with the stated intended use of the model: "Bioscreen is offered as a screening tool to determine if it is appropriate to invest in a full-scale evaluation of natural attenuation at a particular site." (USEPA, 1997).

The observed substantial decreases in concentrations along flowpaths, accompanied with other geochemical indicators, are strong evidence that biodegradation is occurring. It is acknowledged that different rates of degradation likely occur over different areas; however, the flowpaths all extend downgradient of the free product area, where it is agreed by all parties that some degradation is occurring. Also, the average rate of degradation that resulted in a best fit of the Bioscreen model to the **site-specific observed concentration data** along selected groundwater flowpaths was just that: an average degradation rate over the area between monitoring points. The degradation rate is likely higher than the average rate farther away from the free product zone, and lower than the average closer to the free product zone. Wherever possible, site-specific values for aquifer parameters were used in the Bioscreen model, including hydraulic gradients, hydraulic conductivity, and contaminant concentrations. The site-specific, calculated reaction rates fall within the range of literature values reported for these constituents (Howard, 1989)

We agree that, since the screening-level model showed a strong indication that natural attenuation is occurring in the aquifer, a more sophisticated groundwater flow model and

contaminant fate and transport model would be useful in providing a more accurate representation of the fate and transport of contaminants in the aquifer. Different rates of biodegradation, permeability, gradients, etc., could be defined for different portions of the aquifer. Subsection 3.7 of this Workplan presents details of a groundwater flow/contaminant fate and transport model that is proposed to assess the role that natural attenuation plays in restricting the extent of the groundwater plume at the site, under current conditions, and in the future, as free product is removed.

7. **Comment:** Pages 7-5 and 7-6 present a number of calculations of the percent of contaminants that have been degraded. The subsequent figures are based on an assumed high source input and a resulting assumed high degradation rate to produce the current known extent of the plume. However, this type of reverse engineering exercise and the use of these inputs is not a valid way to determine what percentage of the contaminant mass has been degraded.

Response: The model results are constrained by calculations of free product mass (source mass) that have been conducted for the site, and are presented in a May 2000 report entitled Free Product Volume Analysis, prepared for L.E. Carpenter by RMT. Parameter Set 2 assumed a source mass of 180,000 kg, which is close to the estimated site-specific mass of free product of 160,000 kg. The "assumed high source input" is actually matched to observed concentrations at the site near the source, by MW-6. The approach used by the Bioscreen model is to calculate how much mass of a constituent there would be in the aquifer, given observed concentrations at the source, if the constituent were chemically conservative (did not degrade). The difference between the mass that would be in the aquifer if the constituent were chemically conservative, versus the amount currently in the aquifer (based on a best-fit of the model to site-specific observed chemical concentrations along a flowpath), is an estimate of the mass of the constituent that has been degraded. This is a standard approach for calculating the amount of mass that has been biodegraded, and is incorporated into the USEPA's Bioscreen model for this very purpose. While we acknowledge that the Bioscreen model is a screening-level analytical tool, the approach is still a valid, recommended procedure that is appropriate for this screening-level evaluation.

8. **Comment:** Notwithstanding the above, it does appear that biodegradation has effectively kept the plume to a very slow rate of expansion. The rate of expansion may be most easily studied by examining changes in the concentration of natural attenuation parameters at wells along the periphery of the plume. Have the oxygen and ORP values at MW-22 and MW-25 decreased with time? If natural attenuation processes were to be accepted as the means of remediation, the time frame for cleanup would likely be most controlled by the extent of source removal and the supply of oxygen in the aquifer.

Efforts to increase source removal are to be addressed in a pending FFS document. It seems reasonable to consider enhancing the oxygen content of the aquifer as a possible, effective alternative to pump and treat. As mentioned in the comments on the Free Product Alternative Analysis, this could be done as pilot work in tandem with other technologies designed to enhance source removal.

Response: L.E. Carpenter intends to continue periodic monitoring of a number of geochemical indicators of natural attenuation, such as dissolved oxygen, ferrous iron, and redox potential, at the perimeter and downgradient of the free product area. This, in addition to monitoring the concentration of BTEX and DEHP, will help track the chemical nature of the dissolved plume over time and space. This program is outlined in Subsection 3.5 of this Workplan. This monitoring, in conjunction with the three-dimensional contaminant fate and transport modeling that will be conducted for the site, will be used to quantify the role that natural attenuation plays in limiting the extent of the groundwater plume at the site.

Section 3

Proposed Scope of Work

3.1 Objective

The objective of the proposed scope of work is one of continued site characterization ONLY and is not, at this time, a "proposal to sell" monitored natural attenuation (MNA) as a remedial alternative for groundwater impacted with dissolved phase contamination. Rather, the scope is quantitative in nature. The objective focuses on obtaining, understanding, and interpreting additional geochemical, groundwater flow, fate and transport, source mass and distribution data. This will aid in quantifying the extent to which natural attenuation is reducing the mass and concentration of dissolved constituents in the groundwater downgradient of both the free product plume, and the MW19/Hot Spot 1 area. This evaluation will also help to further the development of the comprehensive site conceptual model, and determine whether natural attenuation along with source control actions can be an effective component in the remediation of affected groundwater at the site.

3.2 Approach for Evaluation of Natural Attenuation

Site-specific comments and suggestions from the NJDEP and the USEPA, discussed in Section 2 of this report, have been incorporated into the overall approach for the site. In addition, the approach for evaluating natural attenuation at the site will be conducted in general accordance with published national guidelines on this subject, including *Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (USEPA, 1999), *ASTM Standard Guide for Remediation of Groundwater by Natural Attenuation at Petroleum Release Sites* (ASTM, 1998), *Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring For Natural Attenuation of Fuel Contamination Dissolved In Groundwater* (Wiedemeier, et al., 1995), *Technical Protocol For Evaluating Natural Attenuation of Chlorinated Solvents In Ground Water* (Wiedemeier et al., 1998), and *Monitored Natural Attenuation (MNA) for Ground Water in New Jersey* (NJWEA and NJDEP, 1998). While dealing mainly with fuel-related constituents and chlorinated solvents, the technical protocols presented in these documents are not strictly chemical-specific; rather, the approach is broadly applicable to a variety of contaminants for which natural attenuation is being evaluated.

A conceptual model of the fate and transport of dissolved constituents at the site was presented in Sections 3 and 8 of the May 2000 report on natural attenuation (RMT, 2000a). The report concluded that there was significant evidence that dissolved constituents of concern, notably DEHP, xylenes, and ethylbenzene, were naturally attenuating downgradient of the free product

plume to nondetectable or near-nondetectable concentrations over relatively short flowpaths. The findings and conclusions of the report indicate that it is highly likely that natural attenuation of the constituents of concern is occurring at the site, and that further quantification of the natural attenuation process is warranted.

To further evaluate the effectiveness of natural attenuation of dissolved contaminants, additional investigation is proposed as follows:

- Initial geochemical sampling of soil and groundwater for RNA parameters and analysis along other potential flowpaths, located downgradient of both the free product area, and the MW-19/Hot Spot 1 area.
- Continued sampling for RNA parameters downgradient of the free product and in the MW-19 area, to establish trends in contaminant concentrations over time.
- Development of a contaminant fate and transport modeling, to quantify the rate of degradation of dissolved contaminants at the site.
- Calibrating of the model to actual concentrations of constituents of concern and other natural attenuation parameters at the site, and along downgradient flowpaths.

3.3 Monitoring Well Installation, Development, and Surveying

3.3.1 Monitoring Well Installation

Additional monitoring wells will be installed downgradient of the free product area to help evaluate the natural attenuation of dissolved contaminants. Previously, RMT documented the decrease in contaminants along several flowpaths located downgradient of the free product area (RMT, 2000a). Based on comments from the USEPA and the NJDEP, two additional monitoring wells will be installed to investigate trends in groundwater concentrations along other potential flowpaths. The wells will be installed in substantial accordance with the NJDEP's Field Sampling Procedures Manual by a New Jersey licensed well driller. The wells will be installed in accordance with the procedures outlined in the proposed QAPP, presented as Appendix A.

Upon agency approval, this QAPP will supercede the historical QAPP prepared by Roy F. Weston in 1994. It should also be noted that this QAPP is dynamic in nature and will be amended, as additional proposed scopes require.

Two new wells (MW-27 and MW-28) will be installed on either side of the MW-14S/MW-14I well cluster, located in the far-eastern portion of the subject site (see Figure 2). The purpose of these wells is to ensure that monitoring wells are adequately spaced to determine the actual flowpath downgradient from MW-22R, as well as the lateral concentration gradients

of dissolved-phase constituents. Monitoring well MW-22R is the well furthest away from the free product area that contains levels of contaminants above current cleanup criteria.

A New Jersey licensed well driller will use air-rotary drilling methods to install the wells. Split-spoon samples of soil will be collected every 2.5 feet. The soils will be described as to grain size, soil classification, plasticity, color, odor, and moisture content. Boring logs and well construction logs will be completed for each well location, and will be included in the final report. Four soil samples will be collected for total organic carbon (TOC) analysis to support contaminant transport and natural attenuation modeling.

RMT will install the far-eastern shallow wells to monitor concentrations near the water table, estimated to occur at a depth of approximately 1 to 5 feet. In order to seal the well adequately from potential surface water inflow, the well's screen will be located slightly below the likely location of the water table. The wells will be constructed with a 5-foot screen located at depths of approximately 3 to 8 feet below ground surface (bgs). A deeper well will not be installed at this location because, historically, groundwater concentrations have been limited to the shallow groundwater; deeper monitoring wells at the site, such as nearby MW-14I, MW-14D, have had nondetectable or near-nondetectable concentrations of constituents of concern. Also, groundwater gradients are upward in this area.

Monitoring wells will be constructed with 5-foot-long, 2-inch-diameter stainless steel well screens (0.010-inch slot size). The wells will be completed with stainless-steel riser pipe and 2-inch-diameter stainless-steel slip caps and bottoms. A silica sand filter pack will be placed around and above the well screen for a minimum of 1 foot, and a 2-foot-thick bentonite clay seal will be placed above the filter pack. The wells will be finished approximately 2.5 feet above grade, and covered with a minimum 6-inch-diameter steel protective casing, installed with a locking cover. NJDEP Well Permits, Form A (As-built Specifications) and Form B (Surveyor Documentation) will be completed for each of the new wells.

3.3.2 Monitoring Well Development and Decontamination

RMT will coordinate the development of the monitoring wells by means of over-pumping and bailing after installation is completed. We will continue to develop the wells to minimize formation water turbidity. We will contain all development and decontamination water, stage it in an appropriate on-site location, and remove it off-site along with fluids extracted during monthly enhanced fluid recovery (EFR) events.

Currently, all waste fluids are transported off-site by Clean Venture, Inc. (US EPA ID No. NJ0000027193) and managed by Cycle Chem, Inc. (USEPA ID No. NJD002200046) at their facility located in Elizabeth, New Jersey.

The subcontractor will decontaminate drilling and development equipment as described in the QAPP. Equipment decontamination will take place before and between sampling locations using a high-pressure washer. Sampling equipment will be decontaminated between samples using a soap and distilled water rinse.

3.3.3 Professional Well Survey

A New Jersey-Licensed surveyor will survey the top of the innermost casing (excluding cap) of each of the three monitoring wells to the nearest 0.01 foot. The survey point will be the highest point of the casing, and will be marked on each well after completion. A copy of the revised professional site survey map will be provided in the report outlined in Section 3.8.

3.4 Dedicated Low-Flow Sample Pump Installation

Dedicated low-flow sample pumps will be installed in all of the wells listed in Table 1 to facilitate collection of high-quality representative samples for chemical analysis. The dedicated low flow pumps will be QED™ micropurge bladder pumps (or equivalent) that are capable of achieving low-flow purging and sampling rates, as specified in Attachment 2 to the QAPP (Appendix A).

The low-flow sampling pumps will be left in place in each of the monitoring wells listed in Table 1. This will eliminate the need to conduct pump decontamination procedures between wells, since the pump will not be used to sample any other wells. A detailed discussion of low flow sampling methods is presented in Attachment 1 to the QAPP (Appendix A).

3.5 Monitoring Well Sampling

Table 1 lists monitoring wells that will be sampled as part of the natural attenuation investigation. These include 12 wells located beneath and downgradient of the free product plume, and 12 wells located in the MW19/HS1 area. All of the Table 1 monitoring wells will be sampled in accordance with procedures outlined in the NJDEP's *Field Sampling Procedures Manual* (1992) and the QAPP (see Appendix A). Groundwater samples will be collected at all locations at least 2 weeks (14 days) after the three new wells (MW-19-9A, MW-19-9B and MW-19-10) from MW19/HS1 and the two new wells (MW-27 and MW-28) located downgradient of the free product area have been developed in accordance with Chapter 7 – Section H (5)(c)(i) of the NJDEP's *Field Sampling Procedures Manual*.

Monitoring wells MW-19-9A, MW-19-9B, and MW-19-10 were approved for installation by both agencies in the NJDEP letter dated March 31, 2001 following agency review of both the workplan entitled *Further Off-Site Groundwater Investigation t MW19/Hot Spot 1* (RMT, 2000C), and the RMT workplan modification letter dated February 13, 2001 regarding the previously-mentioned workplan which responded to agency comments presented in an NJDEP letter dated January 5, 2001.

Following the initial round of sampling for natural attenuation parameters, a program of quarterly sampling will be conducted for a period of a year. After a year of quarterly sampling, an evaluation will be made as to the need for, and the frequency of, future sampling rounds.

Table 2 lists natural attenuation parameters that groundwater samples will be analyzed for during this investigation. Primary indicators of natural attenuation that will be sampled include the main constituents of concern, including DEHP, ethylbenzene, and xylenes, as well as benzene and toluene. Additional indicators of natural attenuation that will be analyzed include dissolved oxygen, redox potential, ferrous iron, pH, alkalinity, nitrate, ammonia, sulfate, heterotrophic bacterial plate counts, CO₂, and methane.

Sampling procedures will be conducted in substantial accordance with the SOP for low-flow sampling methods presented in Attachment 1 to the QAPP in Appendix A. Redox potential and dissolved oxygen will be monitored at the beginning and end of purging, using a dissolved oxygen meter and redox electrode and a flow-through cell. Temperature, pH and specific conductance will be measured during purging of the wells prior to sampling. These parameters will also be measured using the YSI Model 6820 flow-through cell, or equivalent. As this instrument is capable of utilizing multiple analytical sondes or probes, the operations, maintenance and calibration is quite detailed. The large O&M manual which cover such items as calibration is provided as a separate document to the field sampling crew at the time of sampling.

Prior to collection of groundwater samples for laboratory analysis, field analyses for CO₂ and alkalinity will be performed using Hach field kits or equivalent. SOPs for these methods are contained within the individual kits prepared by Hach.. Groundwater samples will be collected from all monitoring wells using dedicated bladder pumps and analyzed for DEHP and BTEX. Qualified sampling technicians from RMT, Inc. will perform well purging and sampling activities. Analyses will be performed by Severn Trent Services, an NJDEP-certified laboratory located in Edison, New Jersey (STL Edison).

Quality control samples will be collected per the QAPP, to include one field blank per sampling event, one trip blank per cooler shipment, and one duplicate sample per every 20 samples to be analyzed for BTEX and DEHP.

3.6 Investigation-Derived Wastes

Soil cuttings generated from the drilling process will be containerized in 55-gallon steel drums, labeled, and staged appropriately pending off-site disposal. RMT will relocate the drums to L.E. Carpenter property. RMT will characterize the soil and arrange for appropriate management.

RMT will arrange for placement of the decontamination and monitoring well purge fluids in 55-gallon drums and will dispose of them along with fluid extracted during a monthly EFR event.

3.7 Natural Attenuation Modeling

A three-dimensional contaminant transport model will be used to evaluate the natural attenuation of contaminants at the site. The framework and parameters of the flow and transport model will be discussed with NJDEP and USEPA project staff during the development of the model, to facilitate concurrence on the model design.

Earlier screening-level modeling using the Bioscreen code indicated that a full-scale evaluation of natural attenuation was warranted (RMT, 2000a). For this full-scale evaluation, the widely used Modflow code (McDonald and Harbaugh, 1998) will be used to simulate the groundwater flow system. The Visual Modflow model platform will be used to enhance data input and output. The model domain will include the entire site, and will extend beyond the site to natural hydrologic boundaries where possible.

A multi-layer model will be constructed, with at least two model layers representing the upper units of fill and alluvium, and a third, underlying layer, of highly-permeable sand and gravel. The flow model will utilize appropriate natural boundary conditions, including surface water bodies such as the Rockaway River for the upper layers. Model parameters, especially of hydraulic conductivity, will be based on measured site-specific values wherever possible. The flow model will be calibrated against the extensive database of measured hydraulic head values for the site, and maps of the resulting head distribution for the different geologic units will be presented. Statistical measures of the goodness-of-fit, such as the root mean square of the head difference, will be presented.

The contaminant transport model will use the MT3D code (Zheng, 1990), that couples with Modflow to simulate the fate and transport of constituents of concern. The three major constituents of concern, DEHP, xylenes, and ethylbenzene, will be simulated. Important processes that will be considered in the transport model include advection, dispersion, sorption, and chemical reactions (including biodegradation). Based on earlier simulations using the Bioscreen model (RMT, 2000a), it is highly likely that sorption and chemical reactions play important roles in this system. Initially, conservative migration of the contaminants (with

advection and dispersion only) will be simulated, to demonstrate that ignoring sorption and chemical reactions results in unrealistic simulations of the existing distribution of contaminants in the groundwater. Next, adsorption (along with advection and dispersion) will be incorporated, using site-specific data on the total organic carbon content of the aquifer material, to attempt to simulate the fate and transport of the constituents without chemical reactions.

Substantial evidence has been presented earlier that natural attenuation of dissolved contaminants is an important process at the site. The USEPA has acknowledged that biodegradation of the constituents of concern appears to be an important process at the site (USEPA, 2000). A set of simulations that incorporate realistic rates of biodegradation, constrained by literature values in similar redox settings, will be conducted. Biodegradation rates, constrained within the range of literature values, will be modified as a calibration parameter to match observed patterns of contaminants in the aquifer.

The results of the transport modeling will be calibrated against measured concentrations in groundwater monitoring well samples from the site. The measured values will be plotted on maps of the site, along with contoured, model-predicted values, in order to evaluate the accuracy of the model to represent the transport and fate of contaminants in the groundwater.

3.8 Report

A report that documents the findings, and presents conclusions and recommendations, will be prepared for issuance to the agencies. The report will include the following components:

- Boring logs and well diagrams from the well installation
- Groundwater sampling and analysis data
- Maps and summary tables of concentrations of constituents of concern
- Flow and transport model documentation and results

Findings and conclusions regarding the nature and extent of natural attenuation, and the role that natural attenuation plays in controlling dissolved contaminant concentrations at the site, will be presented.

Section 4 Schedule

RMT will initiate the scope of work described in this Workplan within 3 days of receipt of the written NJDEP/EPA approval of this workplan. The time estimated to complete each of the major components of the Workplan is presented below. There will be an overlap of time for some field operations and model preparation/report preparation.

- | | |
|--|-------------|
| ■ Prepare subcontract for drilling/well installation | 1 week |
| ■ Install monitoring wells, | 2 weeks |
| ■ Initiate groundwater flow model preparation | -- |
| ■ Sample monitoring wells for natural attenuation parameters | 2 - 3 weeks |
| ■ Analyze chemical parameters in certified laboratory | 3 weeks |
| ■ Verify laboratory data, and begin report preparation | 1 week |
| ■ Conduct 3-D groundwater fate and transport modeling | 4 weeks |
| ■ Finalize report | 2 weeks |

It is estimated that the Scope of Work described in this Workplan will be completed within approximately 16 weeks after receipt of agency approval. Extreme weather will cause shifts in this schedule.

Section 5

Site Health and Safety (Minimum Requirements)

All investigative activities related to this workplan must be performed in accordance with all federal, state, and local statutes, regulations, and ordinances. These include, but are not limited to, the standards contained in 29 CFR 1910 General Industry U.S. Department of Labor, Occupational Safety and Health Administration (OSHA). A site-specific Health and Safety Plan (HASP) and Hazard Assessment are presented in Appendix B. A list of emergency points of contact specific to all scopes of work at the LEC site is presented as Appendix C.

Workers will wear standard industrial protective gear, including the following:

- Protective eyeglasses or goggles, as required
- Ear protection, as required
- Rubber gloves, as required
- Tyvek® suits, as required
- Steel-toed boots, mandatory
- Hard hats, when working near drilling rig equipment

Most investigative activities should not lead to the direct contact or inhalation of extracted soil, groundwater, or vapors. In general, avoid direct skin contact with groundwater, decontamination water, and soil. Flush any skin that has come into contact with groundwater, soil, or decontamination water; and remove wetted clothing as soon as practicable.

Breathing zone monitoring for VOCs will be conducted twice daily and, additionally whenever the site health and safety officer believes monitoring is necessary. Monitoring will be conducted using an HNu Photoionization Detector or equivalent. The HNu instrument will be calibrated following the manufacturer's suggested procedure, and at a minimum once per day. Standard calibration gases provided by the vendor or manufacturer will be utilized.

Section 6

References

Following is a summary of reports and manuals referenced as supplemental documents for implementation of this workplan:

6.1 Historical Reports

- NJDEP Administrative Consent Order (ACO) dated September 26, 1986
- NJDEP Superfund Record of Decision (ROD) dated April 1994
- Workplan for Phase I ROD Implementation dated October 1994, Roy F. Weston, Inc.
- Quality Assurance Project Plan (QAPP) dated October 1994, Roy F. Weston, Inc.
- Site Health and Safety Plan (HASP) dated October 1994, Roy F. Weston, Inc.
- Remedial Action Planning Report dated November 1996, Roy F. Weston, Inc.
- NJDEP Field Sampling Procedures Manual (1992)
- Technical Requirements for Site Remediation (N.J.A.C 7:26E-2.1)

6.2 Site Reference and Guidance Manuals

ASTM. 1998. Standard guide for remediation of groundwater by natural attenuation at petroleum release sites. ASTM E 1943-98.

Barker, J.F., G. Patrick, and D. Major. 1987. Natural attenuation of aromatic hydrocarbons in a shallow sand aquifer. *Groundwater Monitoring Review*, Winter 1987, pp. 64-71.

GeoEngineering, Inc. 1990. Report of revised remedial investigation findings, L.E. Carpenter & Company, Wharton, New Jersey site.

Graves, D.A., C.A. Lang, and J.N. Rightmyer. 1994. Biodegradation of bis (2-ethylhexyl) phthalate, ethylbenzene, and xylenes in groundwater: Treatability study supporting *in situ* aquifer bioremediation. *In Proceedings of Second International Conference on In situ and On Site Bioreclamation.*

Howard, P.H. 1989. Handbook of environmental fate and exposure data for organic chemicals., Vol. I. Large Production and Priority Pollutants. Chelsea, Massachusetts, Lewis Publishing.

- McDonald, M. and A. Harbaugh. 1988. A modular three-dimensional finite-difference groundwater flow model. U.S. Geological Survey Techniques of Water Resources Investigations, book 6, 586 pp.
- Newell, C., R. K. McLeod, and J. Gonzales. 1996. Bioscreen – natural attenuation decision support system, user's manual, ver. 1.3. EPA/600/R-96/087.
- New Jersey Water Environment Association, 1998. Proceedings, Monitored natural attenuation (MNA) for groundwater in New Jersey. December, 1998.
- NJDEP (New Jersey Department of Environmental Protection). 1994. Superfund record of decision, L.E. Carpenter/Dayco Corporation Site, Wharton Borough, Morris County, New Jersey. April 1994.
- Rice, D.W., R.D. Grose, J.C. Michaelisen, B.P. Doohar, D.H. MacQueen, S.J. Cullen, W.E. Kastenbergh, L.G. Everett, and M.A. Marino. 1995. California leaking underground fuel tank (LUFT) historical case analyses: California State Water Resources Control Board.
- RMT, Inc. 1998. Second quarter 1998 quarterly monitoring report. September 1998.
- RMT, Inc. 1999. Quarterly monitoring report, 2nd Quarter, 1999, L.E. Carpenter. July 1999.
- RMT, Inc. 2000a. Evaluation of remediation of groundwater by natural attenuation. May 2000.
- RMT, Inc. 2000b. Free Product Volume Analysis. May 2000.
- RMT, Inc. 2000c. Workplan Further Off-Site Investigation at Mw19/Hot Spot 1. October 2000
- RMT, Inc. 2000d. Quarterly Monitoring Report 4th Quarter 2000. February 2001
- USEPA. 1998. Technical protocol for evaluation of natural attenuation of chlorinated solvents in ground water. EPA/600/R-98 128.
- USEPA. 1999. Use of monitored natural attenuation at Superfund, RCRA corrective action, and underground storage tank sites. OSWER Directive 9200.4-17P.
- WDNR. 1996. Groundwater Sampling Desk Reference. PUBL-DG-03796. September 1996.
- Weston. 1992a. Final supplemental remedial investigation addendum for L.E. Carpenter and Company. July 1992.

- Weston. 1992b. Baseline risk assessment, L.E. Carpenter and Company, Wharton, New Jersey. January 1992.
- Weston. 1994. Workplan for Phase 1 ROD implementation, L.E. Carpenter and Company, Wharton, New Jersey. October 1994.
- Weston. 1995. Quarterly progress report, L.E. Carpenter Site, Wharton, New Jersey. Vol. 1 of 2. April 1995.
- Wiedemeier, T., J. T. Wilson, D. Kampbell, R. Miller, and J. Hansen. 1995. Technical protocol for implementing intrinsic remediation with long-term monitoring for natural attenuation of fuel contamination dissolved in groundwater: U.S. Air Force Center for Environmental Excellence, San Antonio, Texas.
- Wiedemeier, T., M. Swanson, D. Montoux, E.K. Gordon, J. T. Wilson, B. Wilson, D. Kampbell, P. Haas, R. Miller, J. Hansen, and F. Chappelle. 1998. Technical protocol for evaluating natural attenuation of chlorinated solvents in ground water: U.S. Environmental Protection Agency National Risk Management Research Laboratory, Cincinnati, Ohio.
- Wolfe, N. L., D.F. Paris, W.C. Steen et al. 1980. Correlation of microbial degradation rates with chemical structure. *Environmental Science and Technology*. Vol. 14, pp. 1143-1146.
- Zheng, C. 1990. MT3D. A modular three-dimensional transport model for simulation of advection, dispersion, and chemical reactions of contaminants in groundwater systems. Model documentation.

Tables

Table 1
Data Quality Objectives and Well Selection Criteria
L.E. Carpenter & Company RNA Workplan

FREE PRODUCT/DISSOLVED PLUME AEC ⁽⁷⁾ ⁽⁸⁾	
Well	Objective
MW-6R	Define source area COC and NA parameter concentrations
MW-2R ⁽⁹⁾	Define COC and NA parameter concentrations and shallow groundwater flow pattern relationships
MW-3 ⁽⁹⁾	Define COC and NA parameter concentrations and shallow groundwater flow pattern relationships
MW-28 ⁽⁹⁾ ⁽¹⁰⁾	Define COC and NA parameter concentrations and shallow groundwater flow pattern relationships
MW-14S ⁽⁹⁾	Define COC and NA parameter concentrations and shallow groundwater flow pattern relationships
MW-14I	Define COC and NA parameter concentrations and vertical gradient relationships between shallow and intermediate groundwater zones.
WP-B7 ⁽⁹⁾	Define COC and NA parameter concentrations and shallow groundwater flow pattern relationships
MW-22R ⁽⁹⁾	Define COC and NA parameter concentrations and shallow groundwater flow pattern relationships
MW-27 ⁽⁹⁾ ⁽¹⁰⁾	Define COC and NA parameter concentrations and shallow groundwater flow pattern relationships
MW-25(R)	Define COC and NA parameter concentrations and shallow groundwater flow pattern relationships
MW-21	Define COC and NA parameter concentrations and shallow groundwater flow pattern relationships
MW-17S ⁽⁵⁾	Establish baseline NA parameter concentrations in an on-site “Shallow Clean Zone”

MW-19/HOTSPOT 1 AEC ⁽⁷⁾ ⁽⁸⁾	
Well ⁽¹⁾ ⁽²⁾ ⁽³⁾ ⁽⁶⁾	Objective
MW-19	Establish baseline dissolved COC and NA parameter concentrations in the MW19/HS1 source area
MW-19-1	Establish baseline dissolved COC and NA parameter concentrations in the MW19/HS1 source area
MW-19-2	Establish baseline dissolved COC and NA parameter concentrations cross-gradient of the MW19/HS1 source area (leading western edge of the plume)
MW-19-3	Establish baseline dissolved COC and NA parameter concentrations up-gradient in the MW19/HS1 source area
MW-19-4	Establish baseline dissolved COC and NA parameter concentrations up-gradient in the MW19/HS1 source area
MW-19-5	Establish baseline dissolved COC and NA parameter concentrations in the MW19/HS1 source area
MW-19-6	Establish baseline dissolved COC and NA parameter concentrations down-gradient in the MW19/HS1 source area
MW-19-7	Establish baseline dissolved COC and NA parameter concentrations down-gradient in the MW19/HS1 source area
MW-19-8	Establish baseline dissolved COC and NA parameter concentrations down-gradient in the MW19/HS1 source area
MW-19-9A ⁽⁴⁾ ⁽¹⁰⁾	Establish baseline dissolved COC and NA parameter concentrations north of Ross Street regional interceptor sewer line
MW-19-9B ⁽⁴⁾ ⁽¹⁰⁾	Establish baseline dissolved COC and NA parameter concentrations north of Ross Street regional interceptor sewer line
MW-19-10 ⁽⁴⁾ ⁽¹⁰⁾	Establish baseline dissolved COC and NA parameter concentrations north of Ross Street regional interceptor sewer line

COCs: Contaminants of Concern

NA: Natural Attenuation

AEC: Area of Environmental Concern

BTEX: benzene, toluene, ethylbenzene, and xylenes

DEHP: Bis (2-ethyl hexyl) phthalate

MW-25(R): “R” designates replacement well

Note(s):

- MW19/HS1: MW19/Hot Spot 1 area of concern; Northwestern portion of the subject site.
- Groundwater flow direction in the MW19/HS1 is assumed to be Northeast; consistent with 2000 groundwater elevation data.
- Definition of MW19/HS1 source area boundary is based on “Isoconcentration Contours for Total BTEX (PPM) in Shallow Groundwater,” presented as Figure 2 in letter entitled NJDEP Review of the MW19/Hot Spot 1 Area Remedial Investigation Report (RMT, May 15, 2000).
- MW-19-9A and MW-19-9B refer to wells MW19-9 and MW19-9D respectively in letter entitled MW19/Hot Spot 1 Well Installation Workplan (RMT, February 13, 2001).
- MW-17S has consistently shown no detection for all COCs (L.E. Carpenter Quarterly Groundwater Monitoring Well 2nd and 4th Quarters only).
- All wells in the MW19/HS1 area are proposed for comprehensive sampling for all parameters listed on Table 2 to establish baseline concentrations throughout the AEC. Once baseline concentrations have been established, specific wells will be selected for long-term monitoring. Rational for well selection for long-term monitoring will be provided to USEPA/NJDEP once established.
- Wells from both on-site AECs have been selected to accurately define groundwater flow patterns.
- All data (flow, and COC/NA parameter concentrations) will be incorporated into the 3D Flow/Fate and Transport Model.
- Data obtained from these wells will more clearly define shallow groundwater flow patters influenced by the Rockaway River and the Air Products drainage ditch
- These are all new wells proposed for installation to better define shallow groundwater flow patterns in each AEC.

Table 2
Natural Attenuation Analysis Parameters

FIELD PARAMETERS	METHOD/EQUIPMENT	FREQUENCY
Dissolved oxygen	360.1 ⁽²⁾ /Probe	Quarterly
Redox potential	⁽⁴⁾ Redox electrode	Quarterly
pH	150.1 ⁽²⁾ /pH electrode	Quarterly
Temperature	From conductivity probe	Quarterly
Electrical conductivity	120.1 ⁽²⁾ /Electrical conductivity meter	Quarterly
CO ₂	Hach kit	Quarterly
Alkalinity (total)	Hach kit	Quarterly
Depth to water	Electric tape	Quarterly
LABORATORY PARAMETERS	METHOD	FREQUENCY
Benzene	602 ⁽¹⁾	Quarterly
Toluene	602 ⁽¹⁾	Quarterly
Ethylbenzene	602 ⁽¹⁾	Quarterly
Xylenes	602 ⁽¹⁾	Quarterly
DEHP	625 ⁽¹⁾	Quarterly
Nitrate	353.2 ⁽²⁾	Annual
Ferrous iron	3500FE ⁽⁴⁾	Quarterly
Sulfate	375.4 ⁽²⁾	Annual
Heterotrophic bacteria plate count	9215B ⁽⁴⁾	Annual
Methane	3810 ⁽³⁾	Annual
Ethane	3810 ⁽³⁾	Annual
Ethene	3810 ⁽³⁾	Annual
Phosphorus	365.2 ⁽²⁾	Annual
Total organic carbon (soil)	9060 ⁽³⁾	During well installation

Notes:

(1) Federal Register 40 CFR Part 136, Vol. 49, No. 209, Test Parameters for the Analysis of Pollutants.

(2) USEPA 600/4-79-020 Methods for Chemical Analysis of Water and Waste.

(3) SW-846, Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, U.S. EPA, 3rd Edition, 1986.

(4) Standard Methods for the Examination of Water and Wastewater, 19th Edition, 1995.

Figures

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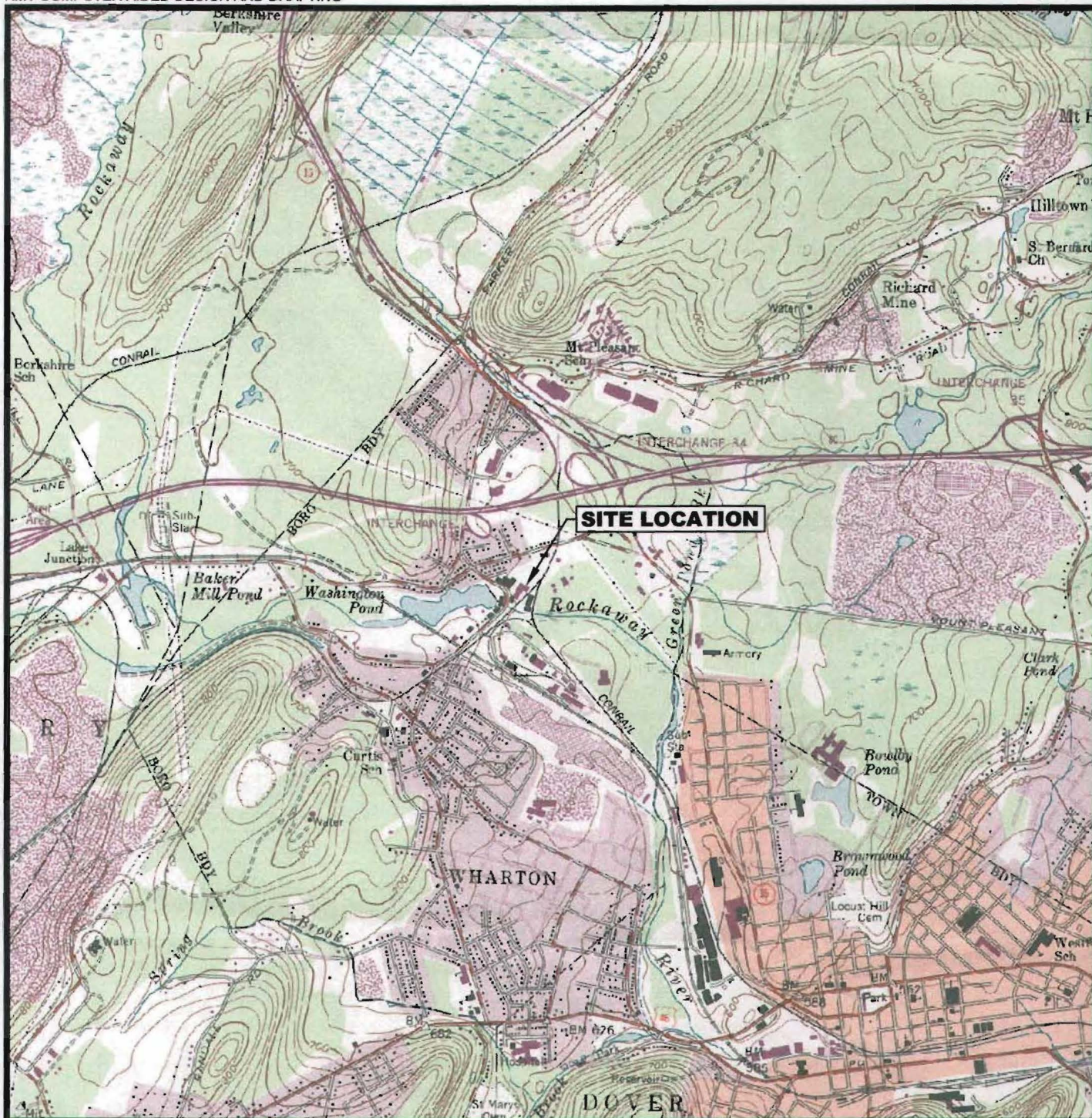
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Operator Name:
Scale:

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PLOT DATA
Drawing Name:



NEW JERSEY



QUADRANGLE LOCATION



0 2000' 4000'



APPROXIMATE SCALE IN FEET

SOURCE

1. BASE MAP DEVELOPED FROM THE DOVER, NEW JERSEY 7.5 MINUTE U.S.G.S. TOPOGRAPHIC QUADRANGLE MAP, DATED 1954, PHOTOREVISED 1981.



**LE CARPENTER
WHARTON, NEW JERSEY**

SITE LOCATION MAP

DRAWN BY:	SJL
APPROVED BY:	NC
PROJECT NUMBER:	3868.23
FILE NUMBER:	38682300.DWG
DATE:	APRIL 2001

FIGURE 1

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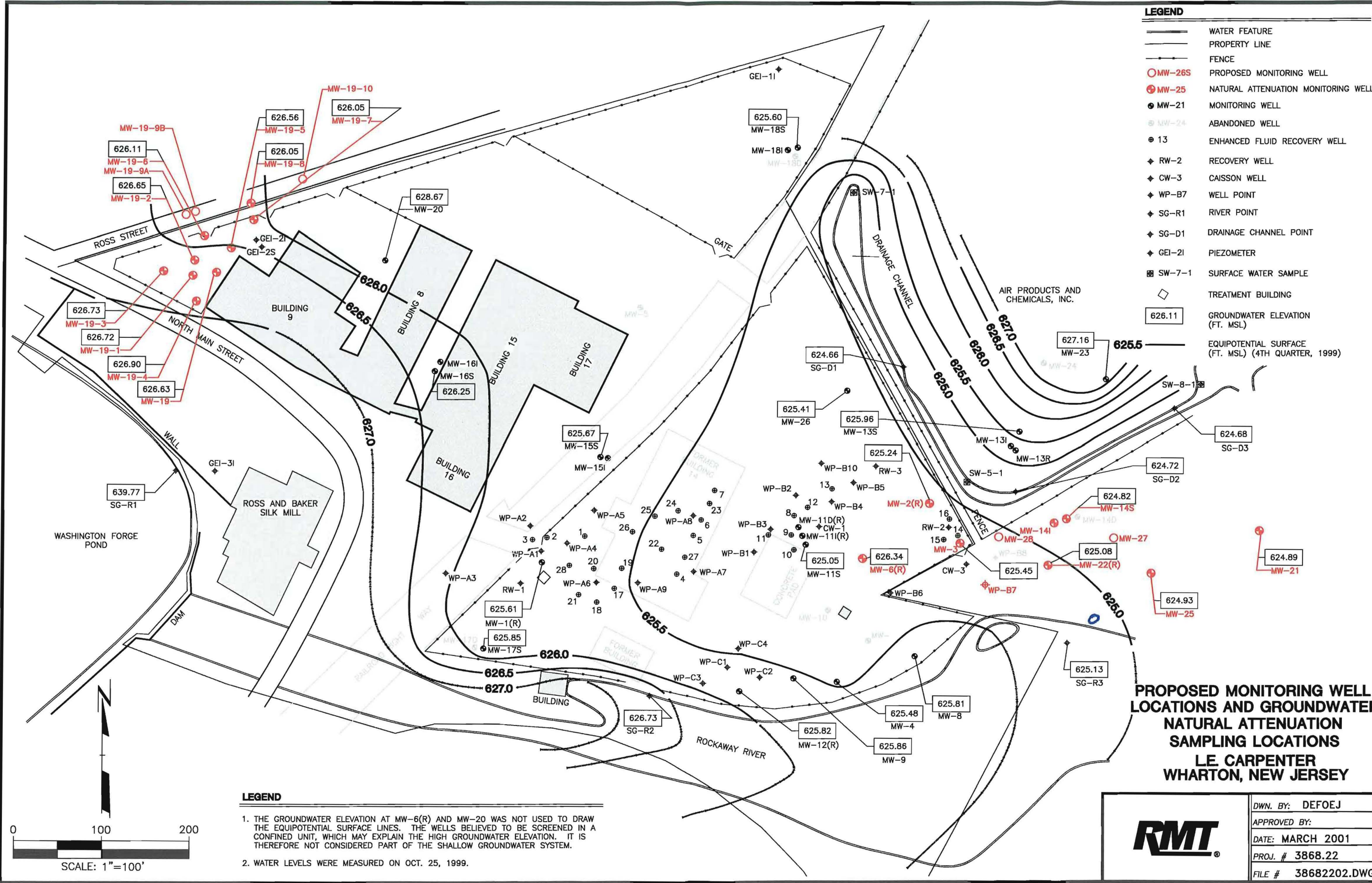


FIGURE 2

**QUALITY ASSURANCE PROJECT PLAN
(QAPP)**

**L.E. CARPENTER AND COMPANY
WHARTON, NEW JERSEY
USEPA ID #NJ002168748**

May 2001

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Acronyms

AA	Atomic Absorption Spectrophotometer
AOC	Administrative Order of Consent
ASTM	American Standards for Testing Materials
BNA	Base-neutral/acid extractables (semivolatile organic compounds)
BETX	Benzene, ethylbenzene, toluene, xylene
CCB	Continuing calibration blank
CCV	Continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (Superfund), as amended by the Superfund Amendments and Reauthorization Act (SARA)
CLP	Contract Laboratory Program
COPC	Constituent of potential concern
CRA	Contract Required Atomic Absorption Spectrophotometer Standard
CRDL	Contract Required Detection Limit
CRI	Contract Required Inductively Coupled Plasma Spectrophotometer Standard
CRQL	Contract Required Quantitation Limit
CRL	Central Regional Laboratory
CVAA	Cold vapor atomic absorption spectrophotometer
DEHP	di(2-ethylhexyl)phthalate
DO	Dissolved oxygen
DQO	Data Quality Objective
FSP	Field Sampling Plan
GC	Gas chromatograph
GFAA	Graphite furnace atomic absorption spectrophotometer
ICB	Initial calibration blank
ICP	Inductively coupled plasma emission spectrophotometer
ICS	Interference check sample

ICV	Initial calibration verification
LRA	Linear range analysis
MDL	Method detection limit
MS/MSD	Matrix spike/matrix spike duplicate
NCP	National Contingency Plan
NIST	National Institute for Standards and Technology
NJDEP	New Jersey Department of Environmental Protection
OSC	On-site Coordinator
PCB	Polychlorinated biphenyl
QA	Quality Assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAS	Routine analytical services
RMT	RMT, Inc.
RPD	Relative percent difference
RPM	Remedial Project Manager
SAS	Special analytical services
SOP	Standard Operating Procedure
TOC	Total organic carbon
USEPA	United States Environmental Protection Agency
VOA	Volatile organic analysis
VOC	Volatile organic compound

Section 1

Project Description

1.1 Introduction

This Quality Assurance Project Plan (QAPP) has been prepared to supercede the *Quality Assurance Project plan for Remedial Actions* (Roy F. Weston, 1994) included as Appendix C in the *Workplan for Phase I Implementation* (Roy F. Weston, 1994). All previous investigations have referenced the approved QAPP prepared by Weston; however as the scope of natural attenuation investigations proposed warrants significant additional QA/QC documentation.

The USEPA requires that all environmental monitoring and measurement efforts mandated or supported by the USEPA be centrally managed by a QA program to ensure that the precision, accuracy, completeness, and representativeness of the RI/FS data are known and documented. This QAPP describes the protocols that will be followed for collecting and handling samples, sample storage, chain-of-custody procedures, and laboratory and field analyses.

This QAPP was prepared in general accordance with the following guidance documents:

- EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, EPA /QA/R-5. (Draft), October 1997.
- Data Quality Objectives Process for Superfund, Interim Final Guidance, OSWER Directive 9355.9-01, September 1993.
- EPA NEIC Policies and Procedures Manual,, EPA 330/978-001-R, May 1986.
- USEPA Contract laboratory Program National Functional Guidelines for Organic Data Review, EPA 540/R-99-008, October 1999.
- USEPA Contract laboratory Program National Functional Guidelines for Inorganic Data Review, EPA 540/R-94/013

1.2 Site Description and Background

A description and background of the site is presented in Section 1 of the Workplan.

1.3 Investigative Objectives

The overall QA objective is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting that will provide results that address the data quality objectives and produce data that are legally defensible. Specific procedures for natural attenuation sampling, chain-of-custody, laboratory instrument calibration, laboratory analysis,

reporting of data, internal quality control, audits, preventive maintenance of field equipment, and corrective action are described in this QAPP. The purpose of this QAPP is to describe the project objectives and organization, functional activities and quality assurance and quality control protocols that will be used to achieve the desired data quality objectives (DQOs) at the L.E. Carpenter Site. The general investigative objectives of the natural attenuation investigation have been described in the Workplan .

1.3.1 Analyses

To meet the data needs, the testing program consists of the following analyses to be performed on groundwater samples as outlined in the above documents:

- BETX Compounds (benzene, ethylbenzene, toluene, xylene)
- DEHP [di(2-ethylhexyl)phthalate]
- Ammonia, nitrate, ferrous iron, sulfate, and phosphorus
- Alkalinity, CO₂ and dissolved oxygen (DO)
- Methane, ethane and ethene.
- pH, Eh, specific conductance, temperature, turbidity,
- Heterotrophic bacteria plate count
- Total organic carbon (TOC)
- Field physical testing for groundwater level

1.3.2 Field Parameters and Uses

Sampling procedures specific to low-flow sampling are described in detail in Attachment 1. Other field instrument calibration and analytical procedures are presented within the O&M manuals provided by the manufacturer of the equipment being used.

Temperature, specific conductance, dissolved oxygen (DO), pH, Eh, and turbidity will be measured from all groundwater samples and be used as indicators of well purging stability as well as in later natural attenuation evaluations.

1.3.3 Laboratory Parameters and Uses

All laboratory analyses will be performed by Severn Trent Laboratories of Edison New Jersey (STL Edison).

BETX compounds will be analyzed using USEPA Method 602. DEHP will be analyzed by Method 625. These organic compounds constitute the contaminants of concern in the groundwater.

Additional parameters, sulfate, ammonia, nitrate, phosphorus, carbon dioxide, methane, ethane, and ethene will be analyzed to determine natural attenuation potential and rate of attenuation.

1.3.4 Intended Data Uses

The Work Plan details the intended data uses, which are summarized briefly here. This sampling phase has been planned to provide the following information to the extent required to:

1. Quantify the extent to which natural attenuation is reducing the mass of concentration of dissolved constituents in the groundwater
2. Determine whether natural attenuation can be an effective element in remediating groundwater at the Site

1.4 Sample Network Design and Rationale

The sample locations and rationale for selected sample locations are described in Table 1 of Section 3 of the Work Plan. Figure 2 of the Work Plan presents sampling locations. The sample analytical parameters are indicated in Table 1 below.

Table 1
Field and Laboratory Analyte List

FIELD METHODOLOGIES		ANALYTES	
Purge Stability using a micro purge cell, probe and electrodes		DO, Eh, pH, specific conductance, temperature, turbidity	
Natural Attenuation criteria using a Hach field kit		CO ₂ and Alkalinity	
LABORATORY METHODOLOGIES		ANALYTES	
Contaminants of Concern	Organics	BTEX	
		DEHP	
Natural Attenuation Criteria	Anions	Sulfate, nitrate	
	Cations	Ammonia, ferrous iron, phosphorus	
	Other	Alkalinity, total organic carbon (soil only)	
	Breakdown gases	Methane, carbon dioxide, ethane and ethene	

1.5 Data Quality Objectives

Data Quality Objectives (DQOs) are qualitative and quantitative statements which specify the quality of the data required to support decisions made during evaluation activities and are based on the end uses of the data to be collected. As such, different data uses may require different levels of data quality. There are two analytical levels which address various data uses and the QA/QC effort and methods required to achieve the desired level of quality. For this natural attenuation evaluation these are as follows:

1.5.1 Screening Data

These data are generated by less precise analytical methods with less rigorous sample preparation than those with definitive level methods. Sample preparation steps may be restricted to simple procedures, such as dilution with a solvent, instead of elaborate extraction/digestion and cleanup. Screening data provide analyte identification and quantification, although the quantification may be relatively imprecise. A portion of screening data may be confirmed using analytical methods and QA/QC procedures and criteria associated with definitive data. Screening data without associated confirmation data are not considered to be data of known quality.

Screening quality data will be used for field-measured parameters such as pH, temperature, specific conductance, dissolved oxygen, alkalinity (field measurement), carbon dioxide (field measurement), ferrous iron, redox potential (ORP; Eh), turbidity, depth to groundwater, and health and safety monitoring. These data will be used for determining the progress of the monitoring well purge process, general groundwater quality, potential for natural attenuation, and possibly as input to computer fate and transport models.

1.5.2 Definitive Data

These data are generated using rigorous analytical methods, such as approved USEPA methods. Data are analyte-specific, with confirmation of analyte identity and concentration. Methods produce tangible raw data (*e.g.*, chromatograms, spectra, digital values) in the form of paper printouts or computer-generated electronic files. Data may be generated at the site or at an off-site location as long as QA/QC requirements are satisfied. For the data to be definitive, either analytical or total measurement error or precision of the analytical method must be determined.

The following data will be collected to meet definitive data quality objectives:

- Groundwater to be analyzed for BTEX and DEHP in accordance with USEPA analytical protocols and data validation procedures.

- Alkalinity (laboratory measurement), ammonia, sulfate, nitrate, phosphorus, TOC, and heterotrophic bacteria plate count will be analyzed in accordance with USEPA-approved analytical methods and laboratory Standard Operating Procedures (SOPs). These data will be used to evaluate the potential for natural attenuation.
- Carbon dioxide (laboratory measurement) will be analyzed by a Hach method. Methane, ethane and ethene will be analyzed using a headspace (Method 3810 - SW-846) and laboratory SOPs. These data will be used to evaluate the potential for natural attenuation.

Section 2

Project Organization and Responsibilities

2.1 Identification of Key Project Personnel

The monitoring well and groundwater sampling will be performed by RMT, Inc, on behalf of the L.E. Carpenter Corporation. The key management and technical staff responsible for the execution of the Remedial Design:

James J. Dexter, CPG, Project Director and **Project Coordinator**

Nicholas J. Clevett, **Project Manager**

Andrew F. Diefendorf, CPG, Senior Consultant **and Technical Coordinator**

Kirsti Sorsa, Ph.D., **QA/QC Officer** and Data Validation Coordinator

Personnel involved in the investigation, and in the generation of data as a result of investigation activities, become a part of the overall Project Quality Assurance program. Within that program, the following individuals have specific responsibilities: the Project Coordinator, the Technical Coordinator and the field personnel. Specific laboratory personnel with Quality Assurance/Quality Control responsibilities include the Laboratory Quality Assurance Officer and the Laboratory Scientists and Technicians.

2.2 USEPA Region II and NJDEP Remedial Project Managers (RPMs)

The USEPA Region II Project Manager and NJDEP Project Manager are Mr. Stephen Cipot and Mrs. Gwen Zervas respectively. These two individuals are the primary project points of contact for their respective agencies and have the responsibility for coordinating regulatory status and issues within/between the USEPA Region II and the NJDEP, and ensuring that all natural attenuation activities comply with applicable standards and technical guidance.

2.3 RMT Project Coordinator

James Dexter will provide senior project management oversight, technical direction, and review RMT's performance on this project. He will also provide input concerning Superfund procedures and conformance with the National Contingency Plan (NCP). He will also coordinate activities with the USEPA and the NJDEP as appropriate.

2.4 RMT Project Manager

Nicholas Clevett will provide overall management of all project initiatives, and will establish and communicate schedules and budgets to both technical staff and the technical coordinator. He will aid the project coordinator with all USEPA and NJDEP initiatives, and will also assist both the project and technical coordinators with overall technical direction.

2.5 RMT Technical Coordinator

Andrew Diefendorf will be responsible for implementation of the Work Plan and will provide overall senior QA/QC. He will coordinate technical staff assignments both in-house and in the field, and as necessary, will contact the USEPA RPM regarding status, technical or regulatory issues.

2.6 RMT Field Coordinator

The Field Coordinator will be the principal field team member primarily responsible for project field coordination and in-field Quality Assurance activities. The Field Coordinator will guide the field personnel in achieving a thorough understanding of the project Quality Assurance Plan and their respective roles relative to one another within the established project framework. The Field Coordinator will also act as the site Health and Safety Representative (HSR).

The Field Coordinator is also responsible for the day-to-day activities of contractor field personnel. In this capacity, the Field Coordinator is responsible for the Quality Assurance of daily project activities and the maintenance of the Quality Assurance Project Plan. Further responsibilities include the review of field notebooks, driller's logs, and other field-related documentation.

2.7 RMT Field Personnel

These environmental staff will be responsible for measuring and recording field parameters; installing monitoring points, collecting, labeling, and transporting samples; and conducting in-field measurements, in accordance with the Work Plan and QAPP. They will report to the Field Coordinator.

2.8 RMT Laboratory Coordinator

The Laboratory QA/QC Coordinator will be responsible for ensuring that applicable QA/QC procedures are followed. This will include reviewing QA/QC procedures and documentation, and directing the data validation and assessment activities, also be responsible for internal performance and system audits.

Section 3

Quality Assurance Objectives for Measurement Data

Data quality requirements are based on the intended use of the data, the measurement process, and the availability of resources. Data quality requirements include detection limits, accuracy, and precision Quality Assurance protocols for the analytical methods to be used and the analyses to be conducted. Specific guidelines for accuracy, precision, completeness, and representativeness are discussed in the following subsections. Field blank, trip blank, decontamination evaluation (*i.e.*, “rinsate” or “equipment”) blanks, and field duplicates described in Section 11 of this QAPP will be subjected to the same Quality Assurance objectives as samples.

3.1 Accuracy

Accuracy is defined as the degree of agreement of a measurement or average of measurements with an accepted reference or true value. Accuracy control limits for the analyses are included in the laboratory SOPs.

The project-specific QA objectives established for accuracy are expressed in the following parameters.

3.1.1 Recovery of Analyte Spikes

Accuracy of laboratory results will be assessed for compliance with the established QC criteria using the analytical results of method blanks, reagent/preparation blanks, matrix spike/matrix spike duplicate samples, field blanks, and trip blanks.

To ensure the accuracy of the analytical procedures, an environmental sample will be randomly selected and spiked with a known amount of the analyte or analytes to be evaluated. In general, a sample spike is included in every set of 20 samples tested on each instrument. The spike sample will then be analyzed. An increase in the analyte concentration due to the spike addition, compared to the concentration in the unspiked sample, determines the percent recovery. The percent recovery (%R) of matrix spike samples will be calculated as follows:

$$\text{Spike Recovery (\%)} = \left(\frac{\text{ug X found in spiked sample} - \text{ug X in native sample}}{\text{ug X added to sample}} \right) \times 100\%$$

Spike recovery data is used to check for possible sample matrix interference and analytical bias. The objectives for the spike recovery from aqueous matrices are given in the USEPA-approved methods and laboratory SOPs.

3.1.2 Reference Materials

Reference materials used as calibration standards or surrogate compounds will be certified, commercially available materials.

3.1.3 Instrument Performance

Instruments used in this project will be checked each day that samples are analyzed to demonstrate instrument performance. The QA objectives for instrument sensitivity, calibration, and performance are established in the USEPA-approved analytical methods and laboratory SOPs. These methods are listed in Section 8 of this QAPP.

3.1.4 Recovery of Surrogates

Surrogate compound recovery is utilized to evaluate proper performance of the analytical method and/or possible matrix interference to the analytical method for organic compounds.

The recovery of a surrogate compound (S) added to a sample will be defined as follows:

$$\text{Recovery \%} = \frac{\text{ug S found in sample}}{\text{ug S added to sample}} \times 100\%$$

This equation assumes that the surrogate is not present in the sample. The objectives for recovery of surrogates from aqueous matrices are given in the USEPA-approved methods and laboratory SOPs.

3.2 Precision

Precision is defined as a measure of mutual agreement among individual measurements of a sample property. Comparing analytical results between MSs/MSDs for organic analysis, and laboratory duplicate analyses for inorganic analysis will assess precision of laboratory analyses. The project QA objectives established for precision are expressed in the following parameters.

3.2.1 Analysis of Standards

One of the QA objectives for this project is that each initial calibration curve and subsequent (*i.e.*, “continuing”) calibration standards meet or exceed the minimum QA criteria established in the USEPA-approved methods and laboratory SOPs.

3.2.2 Analysis of Spiked Samples

A second QA objective for this project is that the results of spiked samples (*i.e.*, matrix spikes) and spiked sample duplicates (*i.e.*, matrix spike duplicates) be within the advisable recovery and Relative Percent Difference (RPD) limits specified in the USEPA-approved methods and laboratory SOPs.

3.2.3 Analysis of Duplicate Samples

A third QA objective for this project is that analyte concentrations be comparable between duplicate samples. This includes 1) duplicate samples collected in the field, 2) duplicate analyses resulting from matrix spike and matrix spike duplicate samples, and 3) results generated from multiple analyses of a sample performed at the laboratory.

A measure of precision is Relative Percent Difference (RPD) of two analyses of the same sample. This measure is applied as a quality control criterion to the recovery of organic matrix spike compounds. Splitting of the sample allows the determination of the precision of the preparation and analytical techniques associated with the duplicate sample. The relative percent difference (RPD) will be calculated using the equation:

$$\% RPD = \frac{S - D}{(S + D)/2} \times 100\%$$

RPD criteria for organic matrix spike compounds are given in the USEPA-approved methods and laboratory SOPs.

3.3 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected under normal conditions. It is expected that 95 percent or more of all samples tested via USEPA and SOP methods will provide data meeting QC acceptance criteria. Following completion of the analytical testing, the percent completeness will be calculated by the following equation:

$$\% Completeness = \frac{\text{Number of valid results}}{\text{Number of possible results}} \times 100\%$$

3.4 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter that is dependent on the proper design of the sampling program and the proper laboratory protocol. The sampling program described in the FSP was designed to provide data that is representative of site conditions. Sampling sites, sampling frequency, sampling procedures, and sampling equipment are addressed in the FSP to obtain representative samples. Other procedures such as sample preservation, appropriate sample containers, sample hold times, and analytical procedures are addressed in this QAPP.

3.5 Comparability

Comparability expresses the confidence with which one data set can be compared with another. The extent to which existing and planned analytical data will be comparable depends on the similarity of sampling and analytical methods. The procedures used to obtain the planned analytical data, as documented in this QAPP, are expected to provide comparable data. These new analytical data, however, may not be directly comparable to existing data because of differences in procedures and QA objectives.

Data acquired for different purposes using different analytical methods, or different DQOs, may not be directly comparable. Samples analyzed using approved methods are expected to be comparable.

Section 4

Sampling Procedures

Specific field procedures for purging wells and actual sample collection procedures are addressed in the attached SOPs for low-flow sampling. Details on sample designation and location are given in the Workplan. The collection of QC blanks, duplicate samples, and spike samples will be discussed in Section 11 of this QAPP.

Sample container, preservation procedures and holding time requirements are presented in Table 2. Pre-cleaned sample containers will be obtained from analytical laboratories or sample bottle suppliers such as I-Chem Research, Inc., New Castle, Delaware, and Daniel Scientific, Simpsonville, South Carolina. The preparation of sample bottles (*e.g.*, preservative added) will be documented.

Table 2
Water Sample Containers, Preservatives, and Holding Times

PARAMETER	CONTAINER(S)*	MINIMUM SAMPLE VOLUME	FIELD PRESERVATION METHOD	HOLDING TIME ⁽¹⁾
Volatile organics	3 x 40 mL glass VOA vials with Teflon® ⁽²⁾ septum	1 x 40 mL VOA vial	Cool to 4°C, add HCl to pH < 2; protect from light	14 days (sample should remain on-site less than 24 hours)
Semivolatile organics (DEHP)	1 x 1,000 mL amber bottle ⁽⁴⁾	1,000 mL	Cool to 4°C	7 days to extraction 40 days from extraction to analysis
Alkalinity	1 x 1,000 mL high-density polyethylene bottle ⁽³⁾	1,000 mL	Cool to 4°C	14 days
Methane, ethane, ethene	2 x 40 mL VOA vials with Teflon® septum ⁽²⁾	1 x 40 mL VOA vial	Cool to 4°C; protect from light; may be preserved with HCl to pH < 2	7 days if unpreserved 14 days if preserved
Phosphorus	Use an aliquot from the alkalinity bottle	100 mL	Cool to 4°C	28 days
Sulfate	Use an aliquot from the alkalinity bottle	100 mL	Cool to 4°C	28 days
Ammonia-N	1 x 1000 mL high-density polyethylene bottle ⁽³⁾	100 mL	Cool to 4°C, add H ₂ SO ₄ to pH <2	28 days
Nitrate-N	1 x 250 mL high-density polyethylene bottle ⁽³⁾	100 mL	Cool to 4°C, add H ₂ SO ₄ to pH <2	28 days
Temperature, Eh, pH, Specific Conductivity, Dissolved Oxygen, Ferrous Iron, Turbidity, field alkalinity, field CO ₂	--	--	--	Immediately after sample collected
Total organic carbon	500-mL high-density polyethylene bottle or glass bottle	30 g	Cool to 4°C	28 days
Moisture content	Use an aliquot from the organic matter bottle	50 g	Cool to 4°C	None specified

Table 2
Water Sample Containers, Preservatives, and Holding Times

PARAMETER	CONTAINER(S)*	MINIMUM SAMPLE VOLUME	FIELD PRESERVATION METHOD	HOLDING TIME ⁽¹⁾
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⁽¹⁾ Starting from time of sample collection.

⁽²⁾ Collect three extra containers for MS/MSD samples.

⁽³⁾ Collect one extra container for sample spike and duplicate analyses.

⁽⁴⁾ Collect two extra containers for MS/MSD samples.

Section 5

Sample Custody

Chain-of-custody documentation enables possession of a sample to be traced from sample collection through analysis and disposal. A sample is considered under custody if:

- the item is in a person's possession;
- the item is in that person's view after being in his or her possession;
- the item was in that person's possession and then placed in a secured location; or
- the item is in a designated and identified secure area.

The field technician performing sample collection activities will be responsible for sample custody in the field. The laboratory sample custodian and analysts will be responsible for custody of the sample at the laboratory.

5.1 Field Chain-of-Custody

Prior to collecting samples in the field, the Field Personnel will obtain the sample bottles necessary for the field operation. Field Personnel will label each sample collected, filling in the appropriate information in waterproof ink. The field sampler will be responsible for collecting the samples and for logging the samples into assigned field notebooks. The field samplers will complete and verify the Chain-of-Custody forms. A sample form can be found in Attachment 3. A copy of the Chain-of-Custody will be placed in the project files and the original will accompany the samples to the laboratory. The identity of field duplicate samples will not be disclosed to the analytical laboratory. Sample analysis request forms will be prepared by the RMT Laboratory Coordinator, or prepared by Field Personnel and reviewed by the RMT Laboratory Coordinator. The analytical request forms will accompany samples, or precede delivery of samples, to the laboratory.

5.2 Transfer of Custody and Sample Shipment

Shipping containers will be sealed and accompanied by the Chain-of-Custody record, with appropriate signatures. The transfer of custody is the responsibility of the Field Personnel and the laboratory staff. The procedures to be implemented are as follows:

- Place completed chain-of-custody forms in a plastic bag, seal the bag, and tape it to the inside cover of the shipping container. After the samples are iced, seal the coolers with strapping tape and custody seals, add the date to the custody form, and ship the coolers to STL using an overnight delivery service. Identify common carriers or intermediate

individuals on the chain-of-custody form, and retain copies of all bills-of-lading. When the samples are received in the laboratory, handle and process them in accordance with the procedures in laboratory SOPs, or specified analytical methods.

5.3 Laboratory Custody Procedures

In the laboratory, a sample custodian will be assigned to receive the samples. Upon receipt of a sample, the custodian will inspect the condition of the samples, reconcile the sample(s) received against the Chain-of-Custody record, log in the sample(s) in the laboratory log book, and store the sample(s) in a secured sample storage room or cabinet maintained at an appropriate temperature until assigned to an analyst for analysis. Custody will be maintained until the sample is discarded.

The sample custodian will inspect the sample for any leakage from the container. A leaky multi-phase sample will not be accepted for analysis as this sample would no longer be a representative sample.

The custodian will examine whether the sample bottle seal is intact or broken, since a broken seal may mean sample tampering and may make analytical results inadmissible in court as evidence. The RMT Laboratory QA/QC Coordinator will be promptly notified of broken seals so that appropriate action may be taken (*e.g.*, collect another sample).

When samples requiring preservation by either acid (except samples for volatile organic compound analysis) or base are received at the laboratory, the pH will be measured and documented. The Laboratory sample custodian will adjust the pH, if necessary, and the RMT Laboratory QA/QC Coordinator will be promptly notified of the pH adjustment so that sample collection procedures can be reviewed to determine if a modification is necessary.

Discrepancies observed between the samples received, the information that is on the Chain-of-Custody record, and the sample analysis request sheet will be resolved before the sample is assigned for analysis. The RMT Laboratory QA/QC Coordinator will be informed of any such discrepancy as well as its resolution. Results of the inspection will be documented in the laboratory sample logbook. Discrepancies will be documented in the analytical case narrative, as appropriate.

5.4 Sample Labels and Seals

Sample labels as shown in Attachment 4 will be affixed to each sample bottle before sample collection. At a minimum, the sample label will contain the following:

- Client - Job Name/Project Number,
- Sample Identification,

- Date and Time Collected (except for duplicate samples),
- Sampler's Signature (or initials), and
- Preservatives Added.

Section 6

Sampling Site Location and Sampling Activity Identification

Details on field documentation procedures are outlined in the Workplan and generally in the text below.

6.1 Field Logbooks

Information pertinent to the soil and ground water investigation will be recorded in field logbooks. Field logbooks will be bound, with consecutively numbered pages. The pages will be dated and signed by the person who is recording the information. Unused space at the bottom of a page will be crossed through. Work sketches or phrases that are recorded but deemed incorrect will be marked through in such a way as to still be legible, yet obviously struck from the text. Mark-throughs will be initialed and dated by the person striking the item.

Persons leading a sampling team or performing a distinct task will be issued a field logbook by the RMT Field Coordinator. That person will maintain the logbook during the RD/RA. At the conclusion of the various phases of the RD/RA, the field books will be collected and reviewed by the Field Coordinator.

6.2 Photographs

Sampling site locations will be identified on a site map. The location will be cross-referenced in the field notebook as to the identification of samples collected from the site location.

Photographs of the sampling site location and the activities occurring at a specific location will be made. Photographs will be cross-referenced with an identification/explanation narrative in the field notebook.

Section 7

Calibration Procedures

7.1 Laboratory Calibration

The calibration procedures to be used for this project are summarized below, and will follow the analytical methods specified in Section 8 of this QAPP.

7.1.1 Instrument Performance and Tune

Prior to analysis of each set of samples and on a daily basis during the analysis, it will be demonstrated that the instruments meet the operating performance standards established in the applicable analytical methods. If an instrument does not meet the performance standards it will be tuned, repaired, or replaced until the performance criteria are achieved.

7.1.2 Calibration Curve

For analyses of analytes listed in Section 8 of this QAPP, instruments will be calibrated or standardized, as appropriate for the analytical method being used, prior to the analysis of each batch of samples. Instrument calibration will be verified on the frequency as prescribed in the applicable protocols (e.g., every 12 hours for volatile and semivolatile organic compounds). A new calibration curve will be established if the response observed in the analysis of the continuing calibration check standard varies outside of prescribed protocol limits. The details to the calibration procedures are described in the analytical methods and laboratory SOPs.

7.2 Field Calibration

In addition to the laboratory analyses conducted during the course of this investigation, field measurements of pH, specific conductance, temperature, dissolved oxygen, Eh, and turbidity will be taken for ground water samples. The following is a brief discussion on field instrument calibration.

Instruments and equipment used to gather, generate, or measure environmental data will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications.

Equipment to be used during the field sampling will be examined to confirm that it is in good operating condition. This includes checking the manufacturer's operating manual and the instructions for each instrument to ensure that maintenance requirements are being observed. Field notes from previous sampling trips will be reviewed so notations on prior equipment problems are not overlooked, and those necessary repairs to equipment have been completed. A spare pH electrode and a thermometer will be sent to sampling locations where pH and temperature measurements are required, including those locations where a specific conductivity probe/thermometer is required.

Field instruments will include a water level indicator and a multi-function flow through cell and meter such as the YSI 6y280 that has multiple sondes for specific conductivity, DO, pH, Eh, Temperature and turbidity. In the event that an internally calibrated field instrument fails to meet calibration/checkout procedures, it will be removed from service.

The equipment will be checked for any mechanical or electrical failures, weak batteries, and cracked or fouled electrodes before mobilizing for field activities. Calibrations and repairs will be recorded in a bound notebook with the date and the name of the person making repairs/calibrations. The equipment will be calibrated before use and at least once for every half day of use. In the event that a multiple sonde meter is not available, single sonde meters such as those listed below will be used for field measurements.

7.2.1 pH

The pH measurements will be made using a Geotech Model P3 flow-through cell (or equivalent). During use, the pH probe will be calibrated utilizing pH 4 and pH 7 buffer solutions. The pH of each sample will be measured in the flow-through cell. The pH measurements will be recorded to the nearest 0.1 pH unit.

7.2.2 Specific Conductance

The specific conductance probe will be calibrated to a stock calibration solution. The calibration must be within 10 percent of the calibration value of the solution. Specific conductance measurements will be made in the flow-through cell, and are automatically corrected by the instrument to 25°C. Measurements will be reported in $\mu\text{mhos/cm}$.

7.2.3 Temperature

Temperature will be measured to the nearest 0.2°C within the flow-through cell. Temperature measurements are utilized directly by the instrument to correct the specific conductance reading.

7.2.4 Turbidity

To assess monitoring well development and the representative nature of groundwater samples, the groundwater will be field-analyzed for turbidity using an in-field nephelometer (Hach Model 2100P, or equivalent). The meter will be calibrated before use according to procedures outlined in the operations manual.

7.2.5 Dissolved Oxygen

The DO measurements will be made using a YSI Model 95 or Geotech Model P3 Dissolved Oxygen Meter (or equivalent). Calibration consists of exposing the probe to a known oxygen concentration such as air at 100 percent relative humidity or water of a known oxygen content, and then adjusting the O₂ CALIB control so the display shows a reading that matches the O₂ concentration of the known sample. The instrument is automatically temperature compensated to an accuracy of ± 1 percent of the dissolved oxygen reading between 5° and 45°C; and to an accuracy of ± 1.5 - 2 percent between 0° and 5°C.

Section 8

Analytical Procedures

8.1 Laboratory Analysis

The laboratory will follow analytical procedures detailed in USEPA-approved methods and laboratory SOPs. Samples will be analyzed for the site-specific constituents of interest as listed in Table 3 of this QAPP.

Analytical parameters used to assess natural attenuation and to engineer the remedial design include alkalinity, ammonia, nitrate, phosphorus, sulfate, methane, ethane, ethene, carbon dioxide, heterotrophic bacteria plate count, and TOC (in soil only). Analytical methods to be used for these analytes are listed below:

- Alkalinity – USEPA Method 310.1;
- Ammonia-N – USEPA Method 350.3;
- Nitrate-N – USEPA Method 353.2;
- Phosphorus – USEPA Method 365.2;
- Sulfate – USEPA Method 375.4 or 300.0;
- Methane, ethane, ethene – carbon dioxide, Method 3810 (SW-846) and laboratory SOP;
- Heterotrophic bacteria plate count – Method 9215B (SW-846);
- TOC – Method 9060 (SW-846)

The reporting limits for the analyses are listed in Table 4.

Table 3
Natural Attenuation and Remedial Design Analytical Methods

FIELD PARAMETERS	METHOD/EQUIPMENT	FREQUENCY
Dissolved oxygen	360.1 ⁽²⁾ /Probe	Quarterly
Redox potential (Eh)	⁽⁴⁾ Redox electrode	Quarterly
pH	150.1 ⁽²⁾ /pH electrode	Quarterly
Temperature	From conductivity probe	Quarterly
Specific conductance	120.1 ⁽²⁾ /Electrical conductivity meter	Quarterly
CO ₂	Hach kit	Quarterly
Alkalinity (total)	Hach kit/4500-CO ₂ -D	Quarterly
Depth to water	Electric tape	Quarterly
LABORATORY PARAMETERS	METHOD	FREQUENCY
Benzene	602 ⁽¹⁾	Quarterly
Toluene	602 ⁽¹⁾	Quarterly
Ethylbenzene	602 ⁽¹⁾	Quarterly
Xylenes	602 ⁽¹⁾	Quarterly
DEHP	625 ⁽¹⁾	Quarterly
Ammonia	350.3 ⁽²⁾	Annual
Nitrate	353.2 ⁽²⁾	Annual
Ferrous iron	3500FE ⁽⁴⁾	Quarterly
Sulfate	375.4 ⁽²⁾ /300.0	Annual
Heterotrophic bacteria plate count	9215B ⁽⁴⁾	Annual
Methane	3810 ⁽³⁾ SOP	Annual
Ethane	3810 ⁽³⁾ SOP	Annual
Ethene	3810 ⁽³⁾ SOP	Annual
Phosphorus	365.2 ⁽²⁾	Annual
Total organic carbon (soil)	9060 ⁽³⁾	During well installation

Notes:

(1) Federal Register 40 CFR Part 136, Vol. 49, No. 209, Test Parameters for the Analysis of Pollutants.

(2) USEPA 600/4-79-020 Methods for Chemical Analysis of Water and Waste.

(3) SW-846, Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, U.S. EPA, 3rd Edition, 1986.

(4) Standard Methods for the Examination of Water and Wastewater, 19th Edition, 1995.

Table 4
Natural Attenuation and Remedial Design Analytical Reporting Limits

Analyte	Reporting Limit
Alkalinity	5 mg/L
Ammonia nitrogen	0.10
Iron (II)	0.1 mg/L
Nitrate nitrogen	0.1 mg/L
Phosphorus	0.03 mg/L
Sulfate	5 mg/L
TOC (soil)	100 mg/kg
Methane	5 µg/L
Carbon Dioxide	5 ppm
Ethane	5 µg/L
Ethene	5 µg/L
Benzene	0.25 µg/L
Toluene	0.25 µg/L
Ethylbenzene	0.25 µg/L
Xylenes (total)	0.25 µg/L
DEHP	0.5 µg/L

8.2 Field Analyses

To ensure that the analytical data gathered in the field are both valid and unbiased, the following steps will be taken:

- Field samplers will be trained in the use of each piece of equipment.
- Operating manuals will accompany each piece of equipment in the field.
- Preventive maintenance programs will be carried out on a scheduled basis.
- Spare components will be taken into the field in case of equipment failure or damage.
- Instruments will be calibrated on a daily basis and rechecked as specified in the SOPs.
- Readings and calibrations will be documented.

The accuracy, sensitivity, and precision of the field analytical techniques for measuring water levels, temperature, specific conductivity, turbidity, DO, redox potential (Eh), and pH are dependent upon the specifications for the instruments used, as well as on the QC techniques employed during their use. Field analytical procedures to be used for this project are described in the attached SOPs and manufacturers O&M Manuals.

Section 9

Data Reporting, Validation, and Reduction

9.1 Field Data

Data validation practices will be followed to assure that raw data are not altered and that an audit trail is developed for data that require reduction. Field data, such as those generated during field measurements, will be entered directly into a bound field notebook. Only direct-reading instrumentation will be employed in the field. With the exception of the temperature correction for specific conductance, no calculation will be involved in field data reduction. Procedures to evaluate field data will primarily include checking for transcription errors and reviewing field notebooks, by field staff. This task is the responsibility of the Field Coordinator. The Field Coordinator will review field measurements recorded in the field books and field chain-of-custody forms to determine that procedures specified in the FSP have been followed. Project team members will be responsible for proofing data transfers.

9.2 Laboratory Data

STL, Edison, New Jersey will perform in-house analytical data reduction under the direction of the Laboratory QA Manager. The Laboratory QA Manager will be responsible for assessing data quality and advising of any data that were rated “preliminary” or “unacceptable” or of other notations that would caution the data user of possible unreliability. Data reduction procedures for the analytical methods are included in the associated laboratory SOPs.

The analytical laboratories will prepare and retain full analytical and QC documentation. Such retained documentation need not be hard (paper) copy, but may be in other storage media (*e.g.*, computer diskette or magnetic tape). As needed, the laboratory will supply a hard copy of the retained information.

For analytical results generated using GC/MS (BETX and DEHP), the laboratory will provide full data packages. The electronic data deliverable will be in the format specified by RMT so that the data can be readily incorporated into a relational database.

For the indicator parameters (*i.e.*, ammonia, nitrate, phosphorus, sulfate, alkalinity, methane, ethane, ethene, carbon dioxide, TOC) used for natural attenuation assessments, the laboratories will provide the following information in each analytical data package submitted:

1. Cover sheet listing the samples included in the report and narrative comments describing problems encountered in analysis.
2. Tabulated analytical results.
3. Summaries of applicable QC sample analysis (spikes, duplicates, laboratory control samples and blanks).

Analytical Data Reports will be available from the laboratory within four weeks following the receipt of the samples.

Upon receipt of the laboratory data reports, the RMT Laboratory QA/QC Coordinator or designated data reviewer will validate the data. Data validation consists of a review of the data for compliance with the established QC criteria based on the spike, duplicate, and blank results provided by the laboratory. Data validation will determine whether the procedures specified in the QAPP were implemented, the DQOs specified in this QAPP were attained, the specified reporting limits were achieved, and the sample holding times were met. The GC/MS instrument performance check sample results will be evaluated. An evaluation of data accuracy, precision, sensitivity, and completeness, based on method-specific criteria, will be performed according to the following guidance documents:

- National Functional Guidelines for Inorganic Data Review. USEPA, February 1994.
- National Functional Guidelines for Organic Data Review. USEPA, October 1999.

Method specifications provided in the laboratory SOPs will be used as guidance for validating data for non-CLP analytes listed in this QAPP.

- The data validation report will address the following items:
 - Overall quality and usability of the data
 - Evaluation of QC data, including precision, accuracy, and completeness of the data
 - Potential sample contamination due to blank contributions
 - Assessment of laboratory and field records
 - Actions regarding specific QC criteria exceedences.

RMT anticipates that data reporting for this phase of the investigation will consist of tabulating analytical results from Analytical Data Reports into summary tables through the use of computerized relational database and spreadsheet software. Reduced data will be placed in the central file maintained by the RMT Technical Coordinator.

9.3 Data Archival

The records management program will track investigation documentation so that it is available when the remedial design has been completed. Accountable documentation include items such as logbooks, field data records, correspondence, Chain-of-Custody records, analytical reports, photographs, computer disks, and final reports. The RMT Technical Coordinator is responsible for maintaining a file in which all accountable documents will be inventoried. Raw data generated during field operations will be filed to eliminate or correct errors arising from the transfer of data. In order to avoid errors in the transfer of data, copies of raw data from the field notebooks and the data as received from the laboratory will be entered into a data file. The data file will serve as the ultimate archive for information and data generated during this Natural Attenuation investigation.

Section 10

Internal Quality Control Checks

Quality Control procedures for field analyses such as pH, specific conductivity, dissolved oxygen, redox potential (Eh), turbidity, and temperature measurements consist of proper instrument calibration.

Internal Quality Control Checks used to assess field sampling precision and bias include the collection of the following blanks and samples:

- **Field/Atmospheric Blanks** - These blanks consist of organic free, deionized water contained in each sample container with any preservatives required for that analysis. These will serve as a QC check on the field sampling methods for the analytes, container cleanliness, and external contamination. A field blank will be submitted for each sampling event.
- **Trip Blanks** - These blanks consists of organic free, deionized water contained in volatile organic compound (VOC) sample containers and preserved similar to VOC samples. These samples serve as a QC check on potential external contamination and/or cross-contamination between VOC samples during shipping and storage. A trip blank will accompany each cooler of VOC samples sent to the laboratory.
- **Rinsate Blanks** - These are samples of organic free, deionized water which have been in contact with decontaminated sampling and/or drilling equipment. These samples serve as a QC check on the decontamination procedure. One Rinsate Blank will be collected for every twenty field samples collected only when non-dedicated equipment is used. The rinsate blank should be collected after pouring analyte-free water over/through appropriate sampling equipment (*e.g.*, bailers, tubing, and pumps).
- **Field Duplicate Samples** - Duplicate samples will be collected to allow determination of analytical repeatability and sample homogeneity. At a minimum, one duplicate sample for every twenty ground and/or surface water samples, and one duplicate for every twenty soil and/or sediment samples, will be collected and submitted for analysis. Duplicate samples will be labeled in a manner such that their sampling point location is not disclosed to the laboratory. The duplicate sample number (*e.g.* DU-1) and its corresponding sample location will be recorded in the field notebook. Sampling date and time will *not* be filled out on the label of the duplicate sample nor on the Chain-of-Custody form in order to not to disclose the duplicate's sample point location.
- **Matrix Spike/Matrix Spike Duplicate Samples** - The laboratory will analyze a matrix spike/matrix spike duplicate (MS/MSD, organic compounds) and sample spike/sample

duplicate (inorganic analytes) sample pairs for as QC checks for accuracy and precision. MS/MSD sample pairs are actually laboratory analytical QC items, which are discussed here because sufficient sample must be collected in the field if these analyses are performed using the samples from the L.E. Carpenter site. Sufficient volume for one MS/MSD sample pair will be collected for every twenty groundwater samples. These samples will allow the amount of recovery of spike constituents to be determined for matrix effects specific to the study site, through the addition of known concentrations of compounds into the sample at the laboratory and then performing the analysis. The spike concentrations added into QC samples will be consistent with the analytical methods and laboratory SOPs.

Section 11

Performance and System Audits

11.1 Field Performance Audits

11.1.1 Internal Field Audits

On-site audits may be performed to review field-related Quality Assurance activities. The Field Coordinator, the Technical Coordinator, or a senior technical scientist may conduct internal audits.

Specific elements of the on-site audit may include, but are not limited to, verification of the following items:

- Completeness and accuracy of sample Chain-of-Custody forms, including documentation of times, dates, transaction descriptions and signatures;
- Completeness and accuracy of sample identification labels, including notation of time, date, location, type of sample, person(s) collecting sample, preservation method used, and type of testing required;
- Completeness and accuracy of field notebooks, including documentation of times, dates, drillers' names, sampling method used, sampling locations, number of samples taken, name of person(s) collecting samples, types of samples, results of field measurements, soil logs and problems encountered during sampling;
- Adherence to health and safety guidelines including wearing of proper protective clothing. Level D protective clothing will be worn at a minimum and will be upgraded, if necessary, as specified in the Health and Safety Plan;
- Adherence to decontamination procedures as outlined in the site Health and Safety Plan, including proper washing or steam cleaning of pumps and pump tubing, bailers, and soil sampling equipment;
- Proper calibration and maintenance of field instruments;
- Adherence to sample collection, preparation, preservation, and storage procedures as outlined in the Work Plan.

11.1.2 External Field Audits

The USEPA Region II and/or the NJDEP may conduct external field audits.

11.2 Laboratory Performance and System Audits

11.2.1 Internal Laboratory Audits

Laboratory audits consist of random data reviews, continuous trend analysis of laboratory QA data, and periodic analysis of performance evaluation samples. Systems audits are performed to verify the continuity of personnel, instrumentation, and quality control requirements contained in the SOPs. Each analytical laboratory is responsible for its own audits.

11.2.2 External Laboratory Audits

USEPA Region II and/or the NJDEP may conduct external laboratory system audits.

Section 12

Preventative Maintenance

The maintenance procedures discussed in the following subsections will be performed to maximize efficiency and minimize downtime in the laboratory and while working on the L.E. Carpenter Site.

12.1 Laboratory Maintenance

As part of their QA/QC program, the analytical laboratory to minimize the occurrence of instrument failure and other system malfunctions conducts a routine preventive maintenance program. Each team in the laboratory performs routine scheduled maintenance and repair or coordinate with the vendor for the repair of all instruments. All laboratory instruments are maintained in accordance with manufacturer's specifications or as appropriate for the instrument. The preventive maintenance procedures for the test instruments will follow established by the laboratory's SOPs. All maintenance activities will be documented in the record books to provide a history of maintenance records.

12.2 Field Maintenance

Routine daily maintenance procedures conducted in the field will include the following:

- Removal of surface dirt and debris from exposed surfaces of the sampling equipment measurement systems.
- Storage of equipment away from the elements.
- Daily inspections of sampling equipment and measurement systems for possible problems (*e.g.*, cracked or clogged lines or tubing; weak batteries).

Spare and replacement parts stored in the field to minimize downtime include the following:

- Appropriately sized batteries
- Extra precleaned sample bottles
- Locks
- Calibration solutions for each meter

Backup instruments and equipment should be available on-site or within 1 day via shipment to avoid delays in the field schedule.

Section 13

Specific Routine Procedures Used to Assess Data Precision Accuracy and Completeness

13.1 Laboratory Data Quality Assessment

The RMT Laboratory Coordinator and QA/QC Coordinator will oversee data validation.

The quality of the laboratory data will be assessed by the Laboratory Coordinator using CLP protocol-specific criteria, validation methods described in Section 9 of this QAPP. Data qualifiers described in the document, if applied to the data, may be added as lower case letters to distinguish them from upper case qualifiers added by the laboratory. The Laboratory Coordinator will check that data packages include a narrative to document variations from the analytical protocol and actions taken by the laboratory to address those variations. The Laboratory QA/QC Coordinator will advise the Project Team of data having questionable or unacceptable quality and procedural deviations noted in the laboratory report narrative.

13.2 Field Data Quality Assessment

To assist in collecting field data accurately and correctly, the Field Coordinator will issue specific instructions to personnel involved in field data acquisition. At the end of each field event the Field Coordinator will review the field books used by project personnel to check that tasks were performed as specified in the instructions. Field books will be reviewed periodically throughout the entire project.

Raw data and reduced data will be submitted by project personnel to the RMT Technical Coordinator for review. Equations, calculations, data transfers, consistent units, and significant figures will be subject to this Quality Assurance review.

Section 14

Corrective Action

Corrective actions may be required for two classes of problems: 1) analytical and equipment problems and 2) nonconformance problems. Analytical and equipment problems may occur during sampling and sample handling, sample preparation, laboratory instrumental analysis, and data review.

If a nonconformance with the established quality control procedures in this QAPP is identified, it will be noted in the logbooks, and corrected in accordance with the QAPP. For noncompliance problems, a corrective action program will be determined and implemented at the time the problem is identified and reported. The person who identifies the problem is responsible for notifying the appropriate field or laboratory personnel. The laboratories will communicate analytical problems to the RMT Technical Coordinator or the RMT Laboratory QA/QC Coordinator. Implementation of corrective action will be confirmed in writing through the same personnel. Field corrective actions will be reported to the RMT Technical Coordinator, implemented, and documented in the field logbook. The RMT Technical Coordinator will report any corrective action that directly impacts project data quality objectives to the USEPA Region II and NJDEP Project Managers.

14.1 Field Measurement Corrective Action

Technical staff and project personnel will be responsible for reporting technical or QA nonconformance or suspected deficiencies of an activity or issued document by reporting the situation to the RMT Field Coordinator or designee. If it is determined that the situation has impacted the quality of the data, a nonconformance report will be completed by the RMT Field Coordinator and distributed to the appropriate personnel. The field staff, in conjunction with the RMT Field Coordinator, will recommend a corrective action. The RMT Field Coordinator will be responsible for ensuring that corrective action for nonconformance has been implemented. The RMT Field Coordinator will be responsible for the following:

- Evaluating all reported nonconformance
- Controlling additional work on nonconforming items
- Determining future action to be taken
- Noting nonconformance in the field logbook
- Reviewing nonconformance reports and corrective actions taken
- Ensuring that nonconformance reports are included in the final project files

If appropriate, the RMT Field Coordinator will ensure that no additional work that is dependent on the nonconforming activity is performed until the corrective actions are completed.

14.2 Laboratory Corrective Action

Corrective actions are required whenever an out-of-control event or potential out-of-control event is noted. The investigative action taken is somewhat dependent on the analysis and the event. Corrective action in the laboratory may occur prior to, during, and after the initial analysis.

A number of conditions, such as broken sample containers, multiple sample phases, low/high pH readings, or potentially high-concentration samples may be identified during sample log-in or just prior to analysis. The corrective action program is under the supervision of the STL Laboratory QA Manager. Following a consultation with laboratory scientists and technicians and team leaders, it may be necessary for the STL Laboratory QA Manager to approve the implementation of corrective action. Some conditions during or after analysis may automatically trigger corrective action or optional procedures. These conditions may include dilution of samples, additional sample extract cleanup, automatic reinjection/reanalysis when certain quality control criteria are not met, etc. Corrective actions may be necessary if any of the following occur:

- QC data are outside the warning or acceptable windows for precision and accuracy.
- Blanks contain target analytes above acceptable levels.
- Undesirable trends are detected in spike recoveries or the RPD between duplicates.
- There are unusual changes in detection limits.
- Deficiencies are detected by the Laboratory during internal or external audits or from the results of performance evaluation samples.
- Inquiries concerning data quality are received.

Corrective action procedures are often handled at the bench level by the analyst, who reviews the preparation or extraction procedure that was used for possible errors, and checks the instrument calibration, spike, and calibration mixes, and the instrument sensitivity. If the problem persists or cannot be identified, the matter may be referred to the laboratory team leader, and/or the Laboratory QA Officer for further investigation. Documentation of the corrective action procedure, whether resolved or not, is placed in the Laboratories project file. The laboratory will provide documentation as to what, if any, corrective actions were initiated concerning this study and report them to the RMT Laboratory QA/QC Coordinator and/or include descriptions of the corrective action(s) in the analytical report narrative.

14.3 Corrective Action During Data Validation and Data Assessment

Data validation corrective actions typically consist of requesting corrections to laboratory reports. The RMT Laboratory QA/QC Coordinator will notify the respective laboratory of incomplete or erroneous reports and will request the issuance of corrected versions. Final summary data tables will not be issued until all data have been validated and all corrections have been made.

The Laboratory QA/QC Coordinator will review the data from the analysis of field, trip, rinsate, and analytical method blanks. If excessive contamination (*i.e.*, levels above allowable limits set within the applicable analytical protocols) is found in the blanks, corrective action will be taken, including requesting that the analytical laboratory:

- Check raw data and calculations, and
- If the contaminating analyte is also present at high levels in field samples, repeat the analysis of the laboratory stored sample or sample extract.

If the contamination does not appear to originate at the laboratory, the Laboratory QA/QC Coordinator, in conjunction with the RMT Technical Coordinator, will review field sampling procedures to determine if a change in field sampling protocol is necessary.

The objective for completeness is 95 percent. If samples or data are lost during sampling and analysis activities, corrective actions will be taken, including:

- Requesting that the analytical laboratory reanalyze stored samples or extracts, if available, and
- Repeating collection and analysis of ground water samples.

Section 15

Quality Assurance Documentation to USEPA

The RMT Technical Coordinator, in conjunction with the Field Coordinator and Laboratory QA/QC Coordinator, will submit a project status report each month. This report may include the following types of information relating to Quality Assurance Activities:

- Significant irregularities noted in the field notebook during the sampling procedure.
- Results of performance and system audits, if conducted.

QA/QC data generated by the laboratory and a case narrative will be included in the CLP data packages.

Pertinent quality assurance documentation will be submitted to the following person at USEPA and NJDEP:

Addressees:

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Case Manager
NJDEP
Bureau of Federal Case Management
Division of Responsible Site Party Remediation
CN028
Trenton, New Jersey 08625-0028
(609) 633-7261 phone
(609) 633-1439 fax
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Mr. Stephen Cipot
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USEPA Region II
290 Broadway, Floor 19
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(212) 637-4411 phone
(212) 637-4429 fax
cipot.stephen@epamail.epa.gov

Section 16

References

- American Public Health Association. 1995. Standard methods for the examination of water and wastes.
- USEPA. 1979. Methods for chemical analysis of water and wastes. USEPA Office of Research and Development. EPA-600/4-79-020, including 1982 and 1984 versions.
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- USEPA. 1987. A compendium of Superfund field operations methods. USEPA, Office of Emergency and Remedial Response, EPA/540/P-87/001.
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- USEPA. 1994. National Functional Guidelines for Inorganic Data Review. EPA-540/R-94-013, February 1994.
- USEPA, Region 4. 1996. Environmental investigations standard operating procedures and quality assurance manual. USEPA Region 4 Science and Ecosystem Division, May 1996.
- USEPA. 1997a. EPA requirements for quality assurance project plans for environmental data operations. Document No. EPA QA/R-5, October 1997.
- USEPA. 1999. National Functional Guidelines for Organic Data Review. EPA-540/R-99-008, October 1999.

Attachment 1

Low-Flow Sampling Methods

Introduction

This appendix summarizes methods that will be used to collect representative groundwater samples for chemical analysis. Equipment and techniques that will be followed to purge and to obtain samples are discussed in detail. This section includes excerpts from the Wisconsin Department of Natural Resources Groundwater Sampling Desk Reference, WDNR PUBL-DG-03796 (September 1996) that deal specifically with low-flow sampling methods.

Wells That Do NOT Purge Dry

This section applies to wells that take less than ~1 hour for the water level in the well to recover (or nearly so) after they have been purged.

The following purging and sampling procedures will be used for wells that do not purge dry. The first procedure listed consistently yields the *highest level of data quality*. The last procedure listed may yield a *lower level of data quality*:

- A. **Low-flow purging < 1 L/min (0.26 gpm), low-flow sampling < 300 ml/min (0.3 L/min or 0.1 gpm) and the monitoring of indicator parameters for stability in a closed flow-through cell.** To obtain the highest-quality, most representative, and consistent groundwater quality measurements and analytical data, purge the well at an average rate of 1 liter/minute (L/min) or less, sample at an average rate of 300 ml/min (0.3 L/min) or less and monitor indicator parameters in a closed flow-through cell until their stability is reached. This procedure will be enhanced by using a dedicated pumping system (left in the well “permanently”).

Purging and sampling rates should be at or less than the natural flow conditions existing in the aquifer influenced by the well. Drawdown during purging should be minimal and the water level in the well should stabilize before the flow rate is decreased to 300 ml/min or less to commence sampling. While maintaining a sampling flow rate of 300 ml/min or less, the water level should be stable or preferably recovering as samples are collected (this ensures that any remaining stagnant water above the pump is not incorporated into the water collected for samples).

Do not reduce a pump’s flow rate by using valves. The resulting pressure drop across the valve (also known as an “orifice effect”) can alter sensitive samples, usually by degassing.

Purge the well until at least three consecutive readings, spaced ~2 minutes or ~0.5 well volumes or more apart, are within the following indicator parameter ranges:

Dissolved Oxygen	±0.2 mg/L
Specific Conductance	±5.0 µmhos/cm for values < 1000 µmhos/cm ±10.0 µmhos/cm for values > 1000 µmhos/cm
pH	±0.1 pH units
Temperature	0.1°C
Turbidity	< 5 NTUs (Required if metals samples will not be filtered. Recommended if sorptive compounds or elements are collected. Optional , but recommended if other compounds or elements are collected)
Eh (optional)	±30 mv

Stable dissolved oxygen, specific conductance and turbidity readings are considered the most reliable parameters for indicating that stagnant water has been replaced by formation water. You may adjust the ± ranges and indicator parameters used to indicate replacement to reflect site-specific data, geochemistry, and hydrogeologic conditions.

Turbidity stabilization and NTU readings below 5 are required if metals samples will not be filtered. Low turbidity readings (*i.e.*, < 5 NTUs), when measured using low-flowing pumping techniques, should represent colloids and particulates naturally mobile in groundwater under natural flow conditions. Turbidity stabilization should also be monitored when collecting sorptive, hydrophobic, or high octanol-water partition coefficient (Kow) compounds or elements.

Or: Purge the well until the readings for each indicator parameter listed above vary within ± 10 percent, over three or more consecutive readings spaced ~2 minutes or ~0.5 well volumes or more apart.

Collect samples from the pump's discharge line before the water enters the flow-through cell. Air pockets in the flow-through cell and probes inserted into the flow-through cell can degrade sample water quality. Either disconnect the sample tubing from the flow-through cell before collecting samples or connect a "tee" junction with an on/off sampling valve between the well and the flow-through cell to collect samples.

Low-flow purging/sampling may not be necessary or may be impractical under the following circumstances:

- Well purges dry before indicator parameters stabilize.
 - Parameters are not affected by aeration, agitation, or the gain or loss of dissolved gasses (and subsequent change in sample pH, etc.).
 - Data quality objectives for a project do not require the level or rigor and stringency inherent in low-flow purging/sampling.
 - An alternative purging and sampling technique has been proven to meet the data quality objectives for the project.
 - Procedures are extremely burdensome and time consuming.
- B. **Purging FOUR well volumes and then sampling with a low-flow pump.** You may use this method when stabilization of the indicator parameters is not achieved in a reasonable amount of time (2 hours). As with the low-flow purging and sampling technique, the purging and sampling rate should still be kept low and should not exceed the natural flow conditions of the aquifer, if possible. The sampling flow rate should be less than the purging flow rate.

Wells That Purge Dry

This section applies to wells that take ~1 or more hours to recover (or nearly so) after they have been purged dry (or nearly so).

Ideally, sample and purge wells at flow rates at or less than the natural flow conditions in the aquifer influenced by the well. Drawdown and turbidity during purging and sampling should be minimal; however, for wells that recover slowly, attaining little drawdown and low turbidity may be nearly impossible. Slowly-recovering wells should still be purged and sampled with minimal disturbance to the water and fines in and around the well and to obtain samples with the lowest turbidity and oxygenation possible.

For slowly-recovering wells that purge dry, bail or pump the well dry, or nearly so, and allow it to recover at least once before collecting samples. If time permits, purge the well a second time. If recovery permits, collect samples from the well within 24 hours of the final purging.

If you are collecting sensitive samples such as VOCs and trace metals, the following procedure should yield samples with the highest data quality. Purge the well dry, or nearly so, using a very low purging rate (< 300 ml/min or 0.1 gpm). Allow the well to recover, or nearly so, at least once before collecting samples. If time permits, purge the well a second time and collect samples within 24 hours. Low-flow pumping should minimize the disturbance of fines in and around the well during purging and sampling and should therefore minimize sample turbidity.

Sample Collection

During sampling, primary objectives and considerations include minimizing sample disturbance, avoiding sample exposure to air and extraneous contamination, and preserving sample integrity throughout collection.

Collect sample parameters in the following order:

1. Unfiltered samples for in-field water quality measurements (not necessary if down well or flow-through cell measurements are taken).
2. Volatile organic compounds (VOCs).
3. Non-filtered, non-preserved (*e.g.*, sulfate, chromium VI, mercury, semi- and non-volatiles, pesticides, PCBs).
4. Non-filtered, preserved (*e.g.*, nitrogen series [ammonia, nitrates, nitrites, etc.], phenolics, total phosphorous, total metals, cyanide, total organic carbon).
5. Filtered, non-preserved (*e.g.*, dissolved chromium VI).
6. Filtered, preserved immediately (*e.g.*, dissolved metals).
7. Miscellaneous parameters.

Collect sulfate samples before sulfuric acid preserved samples (*e.g.*, nitrogen series). Collect nitrogen series samples before nitric acid preserved samples (*e.g.*, boron, dissolved metals). This will prevent accidental contamination of a sample with a preservative intended for another sample (*e.g.*, sulfuric acid preservation contaminating an unpreserved sulfate sample).


Before opening and filling sample containers, check the sampling area for potential sources of extraneous contamination. Make sure the area around the well is clean and that contaminated equipment is kept away from the well. Protect the samples from airborne contaminants such as engine exhaust, blowing dust and organic fumes (*e.g.*, gas cans); sample upwind of these contaminants or remove them before sampling. Choose gloves appropriate for the contaminants you encounter. Change into new, clean gloves every time you sample a new well or suspect your gloves have become contaminated. Do not attempt to decontaminate or reuse gloves; use disposables.

Do not open sample containers until it is time to fill them. Immediately after filling a sample container, if you haven't already done so, add any required preservative—filter first, if required—replace the cap, label the container and place the sample on ice in a cooler. Following these procedures will help minimize sample turbulence, agitation, volatilization, degassing, atmospheric exposure, biodegradation, and exposure to extraneous contamination and heating of samples.

Attachment 2

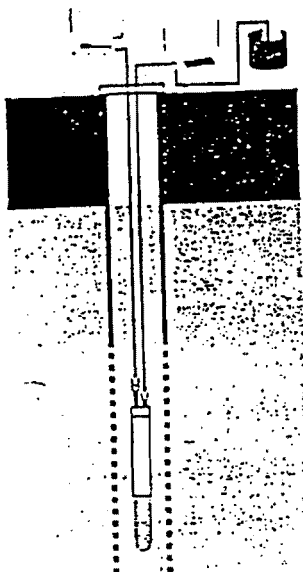
Dedicated Low-Flow Pumps

MICROPURGE

From The Leader in Low-Flow Sampling 

Low-Flow Sampling Equipment Catalog

LOW-FLOW MICROPURGE EQUIPMENT



The choice for:
Long-term monitoring
(more than 4 events)
where low-flow
methods are accepted.

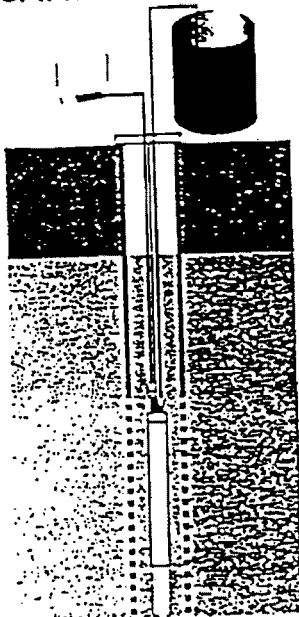
Advantages:

- Most precise samples
- Lowest sampling cost
- Lowest purge volume and disposal cost
- No need to filter in most cases

Disadvantages:

- Higher capital equipment cost
- May not be accepted yet

CONVENTIONAL DEDICATED SAMPLING



The choice for:
Long-term monitoring
(more than 4 events) if
purging 3 to 5 well
volumes is required.

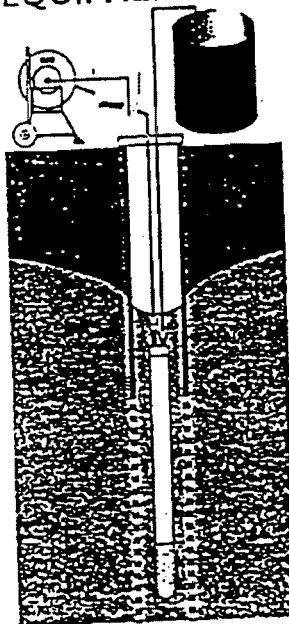
Advantages:

- Proven, accepted sample quality
- Reduced sampling labor cost
- No decontamination or equipment blanks

Disadvantages:

- Higher purge volume and disposal cost
- Higher labor cost than MicroPurge

SAMPLING WITH PORTABLE EQUIPMENT



The choice for:
Short-term monitoring
(less than 4 events) in
existing wells if sample
quality is acceptable.

Advantages:

- Lower capital equipment cost
- Acceptable quality if performed properly
- Equipment ready off-the-shelf

Disadvantages:

- Higher turbidity
- Expensive decon and equipment blanks
- Contamination danger
- Higher labor cost

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e-mail: info@qedenv.com

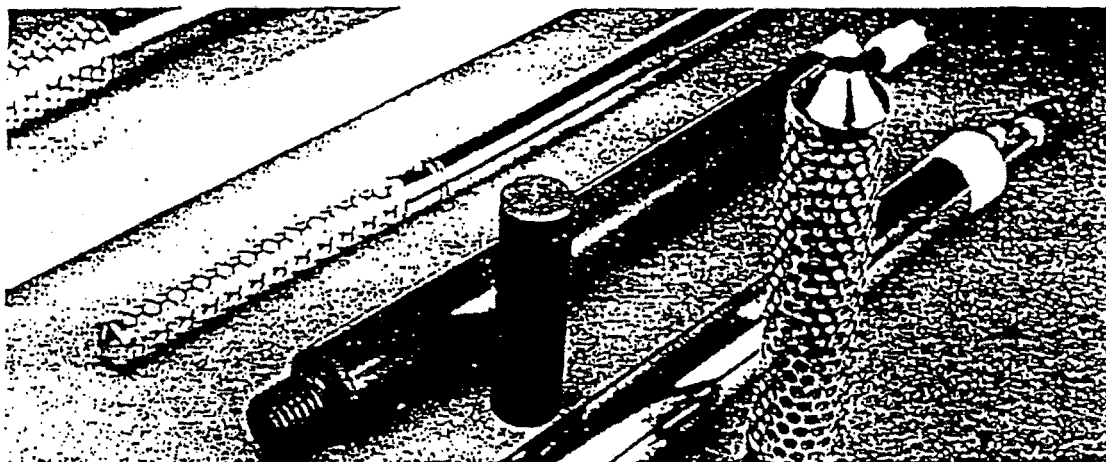
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1/10

Well Wizard® Bladder Pumps: The Low-Flow Sampling Standard



The leaders since 1982 in dedicated pump technology, performance, and support.

The heart of every low-flow ground water monitoring system is the sampling device. For the system to do its job properly, the sampling device must:

- run reliably even at low rates (100 ml/min or less) over a wide range of conditions;
- operate gently without increasing turbidity or altering samples;
- deliver reliable performance for many years without needing frequent repairs or maintenance.

For over 15 years, Well Wizard pumps from QED have been doing all this...at more sites...for more users...than any other system.

The most complete low-flow pump selection

MicroPurge system pumps come in an unsurpassed range of sizes, materials, and capabilities, including models for deep wells, narrow or obstructed casings, and small-volume pumps for low-yield wells. Together with

MicroPurge controllers, flow cells, and accessories, they create the most reliable, cost-effective low-flow system available.

Field proven pump designs and exclusive, high performance PTFE bladder formulation offer the reliability critical to long-term monitoring. QED was first in the industry with a standard 10-year sampling pump warranty.

Unmatched regulatory and user acceptance

Bladder pumps, EPA-accepted for low-flow sampling, have been shown to deliver superior sample accuracy and precision in dozens of independent studies. Nearly 40,000 Well Wizard bladder pumps are in use — more than all other brands and types of dedicated ground water samplers combined.

Well Wizard Pump Advantages

- EPA-accepted low-flow sampling accuracy.
- Models for every well — low yield, short water column, depths to 1,000 feet, casing I.D. down to 1.25".
- Proven reliability since 1982, with the industry's first standard 10-year warranty.
- Exclusive PTFE bladder formulation rated for years more flex life than other bladder materials.

Well Wizard® Bladder Pumps

Designed for superior low-flow sampling performance

Pneumatic bladder pumps operate with a unique, gentle action ideal for low-flow sampling. Timed on/off cycles of compressed air alternately squeeze the flexible bladder to displace water out of the pump, and release it to allow the pump to refill by submergence, without creating any disturbance that could affect sample chemistry. Bladder pumps run easily at low rates for extended times, without the problems of other devices.

- No overheating of high-speed electric pump motors, which can alter samples and ruin the pumps.
- No churning action, like that of bailers or inertial-lift samplers that increase turbidity.
- No suction to cause degassing of dissolved volatile contaminants.

The bladder prevents contact between the pump drive air and the sample, and the downwell equipment is permanently dedicated to each well, so both samples and the well are protected from disturbance or the danger of cross-well contamination.

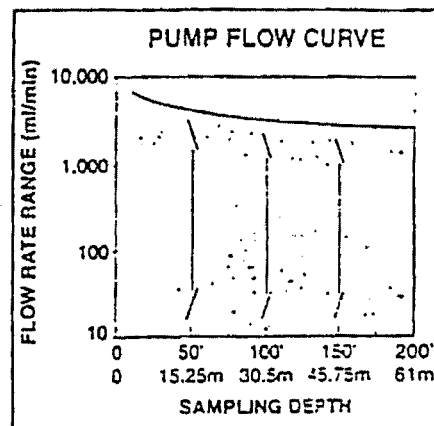
The easiest system to order and use

Well Wizard Bladder Pumps are part of the complete low-flow MicroPurge sampling system engineered for easy installation and use. QED application specialists will help specify the most effective, economical pumps and accessories for your site.

Each pump is cleaned and laboratory-certified to be free of volatile organic compounds, acid extractable and base neutral contaminants. Your system is preassembled, with tubing cut to length, ready to install.

If desired, installation by OSHA-certified field technicians is available. QED customer support — with trained local representatives, 24-hour toll-free hotline, and next-day loaners or service turnaround when needed — backs you with unmatched expertise and service.

More Well Wizard and MicroPurge dedicated sampling systems and pumps have been chosen since 1982 than all other manufacturers' equipment combined. To find out why, call QED today for a Low-Flow Data Sheet and site-specific cost analysis.



This graph shows the extremely wide range of precisely controlled flow rates available from Well Wizard Bladder Pumps and the MicroPurge Model 400 controller. Consult QED for flow rates at greater depths or other special applications.

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MICROPURGE PUMP SPECIFICATIONS

Model No.	Pump Materials	Length	O.D.	Fitting Material	*Tubing Size	Volume (ml)	Max. Lift
T1100M	Tellon	3.3' (1.0 m)	1.66" (4.2 cm)	Tellon	1/4 & 3/8" (6 & 9 mm)	395	250' (75m)
P1101M	PVC	3.4' (1.04 m)	1.66" (4.2 cm)	Polypropylene	1/4 & 3/8" (6 & 9 mm)	395	300' (90m)
P1101HM	PVC	3.3' (1.0 m)	1.66" (4.2 cm)	Stainless Steel	1/4 & 3/8" (6 & 9 mm)	395	600' (180m)
ST1101PM	316 Stainless Steel	3.4' (1.04 m)	1.66" (4.2 cm)	Stainless Steel	1/4 & 3/8" (6 & 9 mm)	395	1,000' (305m)
T1200M	316 S.S. and Tellon	3.4' (1.04 m)	1.50" (3.8 cm)	Stainless Steel	1/4 & 3/8" (6 & 9 mm)	495	300' (90m)
T1250	316 Stainless Steel	1.25' (0.38 m)	1.50" (3.8 cm)	Stainless Steel	1/4 & 1/4" (6 & 6 mm)	100	300' (90m)
P1150	PVC, Tellon	1.63' (0.5 m)	1.66" (4.2 cm)	Polypropylene	1/4 & 1/4" (6 & 6 mm)	130	300' (90m)
T1300	316 S.S. and Tellon	3.8' (1.16 m)	1.00" (2.5 cm)	Stainless Steel	1/4 & 3/8" (6 & 9 mm)	220	300' (90m)

* To choose 1/2" (13 mm) rather than 3/8" (9 mm) discharge tube option, delete suffix M from pump model number.

Intake Screen Specifications

Model No.	Material	Screen Size	Fits Pump Model(s)
35200	Stainless Steel	.001" (0.25 mm) mesh	T1200, T1250
37789	PVC	.010" (0.25 mm) slot	P1101, P1101H
7727	PVC	.010" (0.25 mm) slot	P1250 (also P1101, P1101H)
733	Tellon	.010" (0.25 mm) slot	T1100

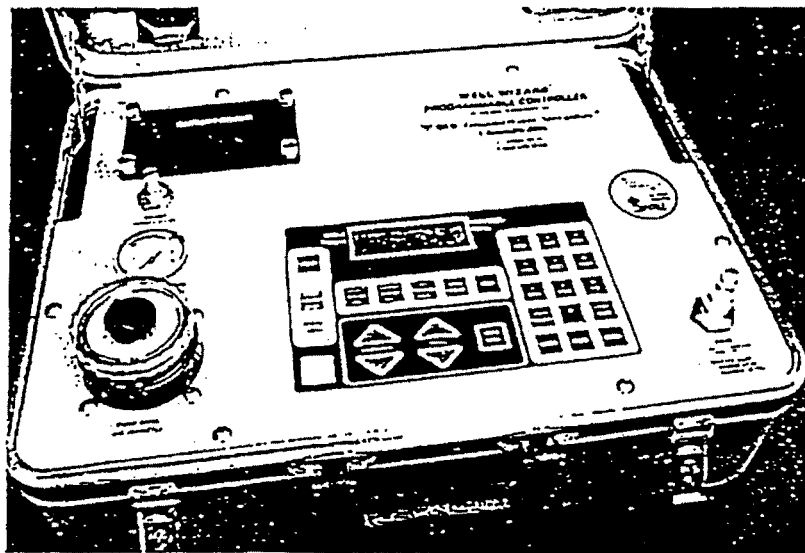
Note: Pump models ST1101P, T1300 include intake screens. Screens are optional on other pump models, but are required for full 10-year warranty coverage.

Materials Specifications

Stainless Steel:	Type 316 electropolished
PVC:	NSF-grade, extruded specifically for QED with no markings or lubricants.
Tellon (pumps):	duPont Tellon® and other premium PTFE resins
Tellon (bladders):	O-Ilex exclusive 200,000 cycle rated PTFE.

Tellon is a registered duPont trademark.

MicroPurge® Smart Controller: Programmed Purging and Sampling



Digital controller provides simple, repeatable operation for precision purging and accurate low-flow sampling.

The MicroPurge® Model 400 Controller is the only pneumatic pump controller designed specifically for low-flow sampling.

Precise flow control capable of minimizing rates to 100 ml/min or less is essential. The Model 400 achieves this with instant recall of controller settings and direct, single turn pressure adjustment. The graduated regulator allows exact pressure setting without cycling the controller, preventing sample volume loss in low yield wells.

Saves time in the field

The simple, repeatable operation of the MicroPurge 400 Controller makes low-flow sampling faster and easier, event after event. Exact digital timer display permits rapid optimization.

Consistent purging and accurate,

reproducible sampling are assured even with different field personnel, thanks to easy recall of stored settings. The "manual sample" mode simplifies filtration and sampling even more; one button pauses the controller while you ready sample bottles, then starts the pump again for sampling.

Easy to operate and upgrade

Well data entry and controller commands are easy with the alphanumeric keypad and LCD display. Software is on replaceable EEPROM chips to allow for future upgrading.

Take control of your sampling program. Call QED today for a Low-Flow Data Sheet and site-specific cost analysis.

Smart Controller Advantages

- Save field time with simple operation and instant recall of stored control settings for up to 500 wells.
- Depth-graduated pressure regulator allows precise flow rate control for low-flow sampling.
- Easy adjustment and pump optimization with precision cycle times displayed.

MicroPurge® Controller

Proven reliability and performance

The MicroPurge Model 400 Controller regulates the alternating on/off air supply and exhaust cycle (discharge and refill modes) required to operate pneumatic bladder pumps — the EPA-accepted choice for low-flow, minimal draw-down sampling.

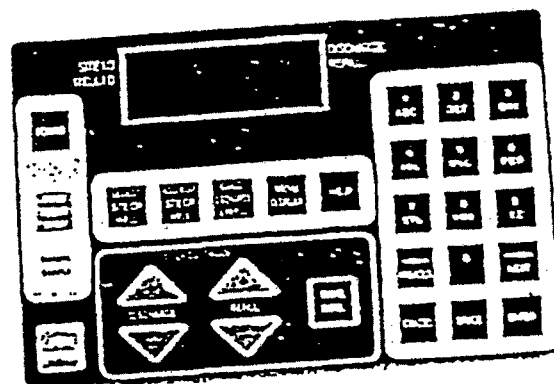
The 400 Controller is the product of QED's 15 years of leadership in the design and manufacture of ground water sampling systems. Its heavy-duty pneumatic valves, proven during years of service in other QED equipment, deliver reliable performance under the toughest field conditions.

The lightweight, self-contained unit comes in a rugged, weather-resistant case. Power is supplied by 8 easy-to-replace AA alkaline batteries; one set of batteries lasts approximately 7 days of 24-hour continuous operation (with 6-second refill and discharge cycles). A digital battery life indicator makes sure you won't run out of power between wells.

As much control as you'll ever need

The Model 400 can be used in basic mode for simple pump operation or with all of its advanced functions.

- Data storage for 500 wells (10 sites x 50 wells each).
- Displays timer settings, refill/discharge mode, well and site I.D.
- Drive air regulator calibrated in PSIG and Feet of Water.
- Single turn control over the entire range (0-120 PSIG, 0-250') — no need to adjust and cycle to observe pressure setting.



The large, user-friendly alphanumeric keypad and LCD display make timer setting and pump control faster and easier.

For up-to-date specifications go to:
www.micropurge.com

MICROPURGE CONTROLLER SPECIFICATIONS

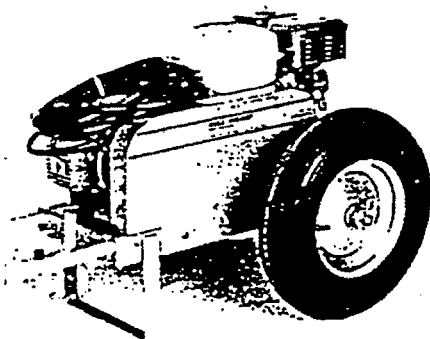
Model No.:	400
Overall Dimensions:	18" x 14" x 7.5" (46 x 36 x 19 cm)
Overall Weight:	17 lbs. (7.7 kg)
Case:	Ultra High Molecular Weight Polyethylene (resists shock, oil, fuel, solvent, acid, cold & heat), corrosion resistant hardware.
Keyboard:	29 key membrane
Display:	LCD — 4 lines x 20 characters
Pump Drive Air	
Throttle:	Single turn analog knob, graduated in PSIG and Feet of Water Pressure
Power:	12 VDC (8 AA alkaline batteries)
Battery Life:	Approx. 7 24-hour days continuous operation (with 6-second refill and discharge cycles)
Software:	Replaceable EEPROM
Memory:	500 well settings (10 sites x 50 wells)
Warranty:	1 year
Max. Pressure:	120 psi
Max. Pump Depth:	250 feet (75 meters)
Operating Environment:	
Temperature:	14 ° to 120 °F (-10 ° to 49 °C)
Storage Temp.:	-4 ° to 158 °F (-20 ° to 70 °C)
Air/Gas Supply:	Compressed air or nitrogen tanks or oilless compressor

QED Compressors and Controllers: Compact, Self-Contained Power

Your choice of gasoline or electric powered compressors and electronic or pneumatic controllers makes sampling easier.

To get a portable, reliable air source that's right for your site, choose one of our proven gasoline-powered or electric compressors along with an electronic or pneumatic controller.

Well Wizard[®] pneumatic controllers are also compatible with bottled compressed gas, for use in high pressure, deep well sampling applications or at other sites where appropriate.



Gasoline-powered air supply

The 41000 Series gasoline engine-driven compressors provide dependable performance on a rugged cart that goes anywhere.

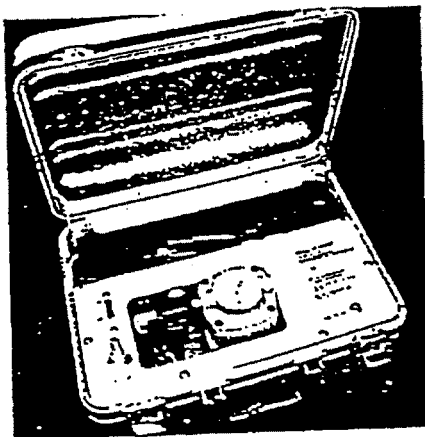
Standard 100 psi and high-pressure 165 psi versions come with clean-running 4-cycle Honda industrial/commercial engines — no slop-oil/gas mixing.

Operating on regular unleaded gasoline, QED compressor engine choices meet California exhaust emission standards.

The whole assembly is mounted on a strong, lightweight cart engineered for easy portability and long lasting service in the field.

Compact electric air source

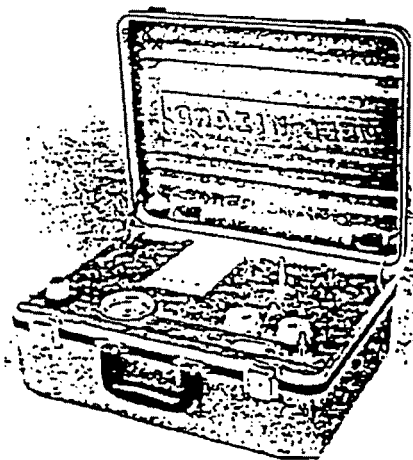
Model 3020 electric compressors provide 100 psi output ideal for



MicroPurge equipment use in a convenient, portable package now only 15 x 11 x 6.5" and 15 pounds. Just connect the supplied cables to your 12 VDC truck or car battery.

Air flow is sufficient for low-flow sampling to depths as great as 200 feet, or conventional sample pump operation to 75 feet.

Reliable controllers and compressor/controller carts



In addition to MicroPurge Model 400 electronic controllers (pp. 6-7), QED makes Well Wizard 3013 Series

pneumatic controllers. Fully adjustable units can operate high rate purge pumps, yet be throttled back to deliver precise EPA-recommended low flow rates for sampling.

All models are compatible with a wide range of gas sources: high pressure models allow maximum lifts to 1,000 feet with bottled high-pressure compressed gas.

3111 Series compressor/controller carts combine a pneumatic 3013 controller with a 41000 series compressor cart. Self-contained, one-person portability, fast setup, and unattended operation reduce sampling labor.

All QED systems come complete — no extra charges for hoses or other necessary equipment.

QED Air Source Advantages

- Engineered for one-person portability — in a pick-up truck or on foot.
- Proven reliability under the toughest field conditions since 1982.
- Oilless compressors with 4-cycle engines — no oily smoke, maximum protection against contamination.
- Precision sampling pump control over an unsurpassed range of depths (to 1,000 feet).

Compressors and Controllers

Heavy-duty compressors for workhorse performance

QED has engineered our gasoline-powered compressors for long-lasting, reliable performance. Oversized compressors have heavier-than-standard castings for better heat dissipation in rugged field duty. Opposable pistons minimize noise, vibration, and wear. A heavy-duty belt guard protects personnel.

Engines are 4-cycle Honda industrial/commercial models, for first-pull starting every time. They run on regular unleaded gasoline, with no oil mixing and no "blue smoke" problems.

The tough, compact Model 3020 electric compressor — now 40% smaller and lighter in weight — provides dependable 100 psi output anywhere you can hook it up to a 12 VDC car or truck battery. It comes complete and ready to use with air hose coupling and battery cable in a durable hardshell case.

All QED air sources are supplied with low-maintenance filter modules to remove particulates and contaminants that may be present in the site air, plus moisture knockout vents to keep water out of the pump air supply.

Simple, rugged pneumatic controllers

All-pneumatic Well Wizard controllers have no batteries to recharge or replace — if you've got air pressure, they've got power. QED's third-generation pneumatic logic provides precise, controlled on/off cycles to power sampling pumps at any flow rate, with inherent shock and moisture resistance to withstand harsh field conditions.

Their toughness is legendary — Well Wizard controllers have survived being left out in storms, dropping from trucks, even having their lids ripped off — without missing a single pump cycle.

Carts that keep rolling

The ideal platform for a trouble-free air source is a rugged, field-proven QED cart.

High-flotation tires allow true one-person portability over rough terrain, even in heavy mud or snow. The cart platform is built with underside bracing to provide improved rigidity and increased life. Engine/compressor stabilization minimizes competing vibration to reduce wear and tear on all components.

Specially engineered handle (and wheels, if necessary) disassemble quickly and easily without tools for transport and handling. A new lifting handle makes the whole assembly more convenient to move in and out of vehicles.

Don't be fooled by so-called "equivalent" products. Years of field-testing and engineering improvements make QED carts and air sources the most practical, dependable units you can find.

AIR SOURCE SPECIFICATIONS

Compressor and Compressor/Controller Cart Specifications

Model No.	Maximum Pressure	Max. Lift (Internal)	Max. Lift (External)	Output (at listed pressure)	Dimensions (LxWxH)	Weight
41000LR*	100 psi (690 kPa)	200' (61 m)	—	4.3 SCFM @ 100 psi (7.3 m ³ /h @ 690 kPa)	49.5 x 25.5 x 21.5" (126 x 65 x 55 cm)	87 lbs. (40 kg)
3111LR†	100 psi (690 kPa)	200' (61 m)	250' (76 m)	4.3 SCFM @ 100 psi (7.3 m ³ /h @ 690 kPa)	49.5 x 25.5 x 21.5" (126 x 65 x 55 cm)	111 lbs. (50 kg)
3111LH††	165 psi (1138 kPa)	320' (97.5 m)	600' (183 m)	2.2 SCFM @ 100 psi (3.74 m ³ /h @ 690 kPa) 2.1 SCFM @ 165 psi (3.57 m ³ /h @ 1138 kPa)	49.5 x 25.5 x 21.5" (126 x 65 x 55 cm)	115 lbs. (52 kg)
3020	100 psi (690 kPa)	#200' (61 m)	—	0.21 SCFM @ 100 psi (0.357 m ³ /h @ 690 kPa)	15 x 11 x 6.5" (38 x 28 x 17 cm)	15 lbs. (7 kg)

* Includes cart

† Includes cart and 3013 Controller

†† Includes cart and 3013H Controller

Maximum lift for MicroPurge low-flow equipment applications; for conventional sampling, maximum lift = 75 feet (23 m)

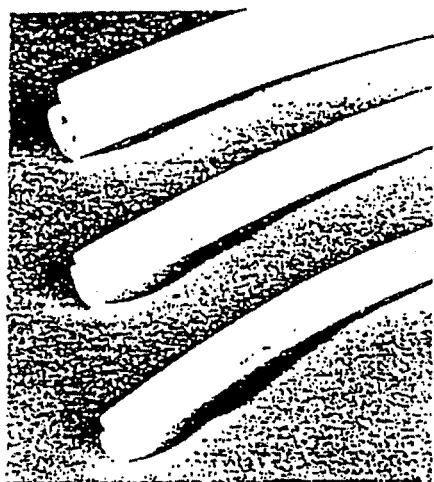
Pneumatic Controller Specifications

Model No.	Maximum Pressure	Maximum Lift	Dimensions (LxWxH)	Weight
3013	125 psi (862 kPa)	250' (76 m)	18 x 14 x 7.5" (46 x 36 x 19 cm)	22 lbs. (10 kg)
3013H	300 psi (2070 kPa)	600' (183 m)	18 x 14 x 7.5" (46 x 36 x 19 cm)	26 lbs. (12 kg)
3013UH	500 psi (3448 kPa)	1000' (305 m)	18 x 14 x 7.5" (46 x 36 x 19 cm)	32 lbs. (15 kg)

Note: For Model 400 Electronic Controller specifications, see page 7.

Sample Pump Tubing

Innovative, problem-solving tubing in the widest range of materials and sizes.



The last thing your sample contacts before collection is the sample tubing; this demands the highest standards in tubing quality. QED tubing innovations protect your sample integrity while making system installation and operation easier and more economical.

Twin-line simplicity

Our standard twin-line air supply/sample discharge tubing has a continuous heat-welded bond. It costs a little more than loose or cable-tied tubing, but users report

several major benefits. It saves time and hassle by preventing tangles or hangups during pump installation and maintenance, and avoids entanglement with portable water level meters or other equipment.

Tubing assemblies are cut to exact length and pre-assembled to well cap and pump per customer specifications at no extra cost. QED also stocks the largest variety of discharge adapters, elbows, and couplers — what you'd expect from the leading supplier of ground water sampling equipment.

Quality materials and samples

All tubing is controlled quality, virgin grade material that passes QED's rigorous standards — the toughest in the industry. Economical Teflon-lined polyethylene tubing the most frequently used, with Teflon on the inside of the sample tubing, where it's really needed.

Other material choices include all-Teflon, polyethylene, and polypropylene (for deep-well use).

QED also stocks bulk tubing and many other sizes and materials; inquire for details.

QED Tubing Advantages

- **Twin-line bonded tubing without the hassles of cable ties or loose tubing.**
- **Custom cutting and assembly — systems are pre-assembled, leak-tested, and poly-bagged for easier installation with no left-over tubing.**
- **Highest quality materials — 100% virgin grade, extruded in USA with US manufactured resins, with no regrind, printing, additives, or mold release agents.**
- **True continuous lengths — no unexpected joins or couplings.**
- **Convenient discharge options — MicroPurge discharge adapters or Teflon or polypropylene elbows allow easy sampling without bending, kinking, or sample alteration.**

SAMPLE TUBING SPECIFICATIONS

Model No.	Material	Air Supply O.D.	Discharge O.D.	Maximum Pressure	Maximum Depth	Min. Bend Radius
P5000	Polyethylene	1/4" (6 mm)	3/8" (9 mm)	300 psi (2070 kPa)	600' (183 m)	1.25" (3 cm)
PT5000	Teflon-lined PE	1/4" (6 mm)	3/8" (9 mm)	300 psi (2070 kPa)	600' (183 m)	1.25" (3 cm)
T5010	Teflon	1/4" (6 mm)	3/8" (9 mm)	300 psi (2070 kPa)	600' (183 m)	2.5" (6 cm)
PR5010	Polypropylene	1/4" (6 mm)	3/8" (9 mm)	300 psi (2070 kPa)	600' (183 m)	1.25" (3 cm)
P5100	Polyethylene	1/4" (6 mm)	1/2" (13 mm)	200 psi (1380 kPa)	400' (122 m)	2.5" (6 cm)
PT5100	Teflon-lined PE	1/4" (6 mm)	1/2" (13 mm)	200 psi (1380 kPa)	400' (122 m)	2.5" (6 cm)
T5110	Teflon	1/4" (6 mm)	1/2" (13 mm)	240 psi (1650 kPa)	500' (153 m)	3.0" (7.5 cm)
PR5100	Polypropylene	1/4" (6 mm)	1/2" (13 mm)	300 psi (2070 kPa)	600' (183 m)	2.5" (6 cm)
P5200	Polyethylene	1/4" (6 mm)	1/4" (6 mm)	300 psi (2070 kPa)	600' (183 m)	1.0" (2.5 cm)
PT5200	Teflon-lined PE	1/4" (6 mm)	1/4" (6 mm)	300 psi (2070 kPa)	600' (183 m)	1.0" (2.5 cm)
T5200	Teflon	1/4" (6 mm)	1/4" (6 mm)	300 psi (2070 kPa)	600' (183 m)	1.0" (2.5 cm)

Note: Polypropylene tubing is cable-tied, not heat-bonded.

Tubing I.D. is as follows: 1/4" (6 mm) O.D. = 0.17" (4.3 mm) I.D.; 3/8" (9 mm) O.D. = 0.25" (6 mm) I.D.; 1/2" (13 mm) O.D. = 0.375" (9 mm) I.D.

Well Cap Assemblies

Standard and custom caps make every well easier to sample.

A cap that really fits the wellhead, with properly designed fittings for ready access, can make the difference between easy installation and sampling or problems requiring on-site modification.

We'll fit your well, no matter what it takes

Since 1982, QED has developed the industry's broadest range of sampling system well caps, engineered for secure hardware attachment and well protection. Our large stock of standard, locking, and/or sealing caps will fit most wells off the shelf, but we've also supplied thousands of customized designs — with rapid, responsive service to complete even the largest installations on time.

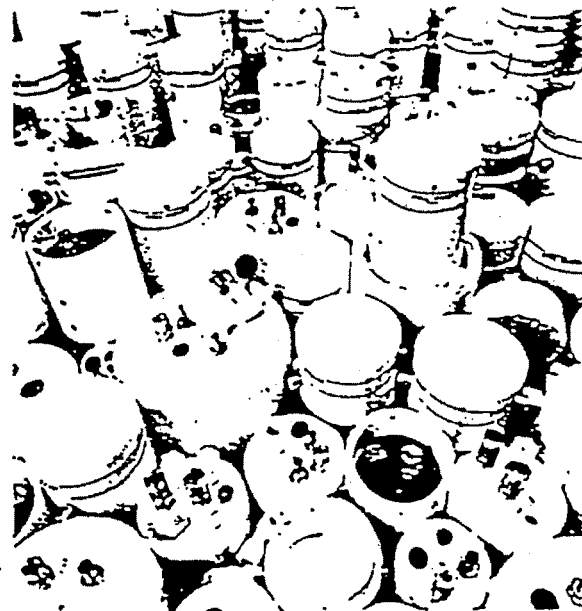
Standard non-locking PVC cap assemblies with brass and polypropylene fittings deliver space-saving performance where wells are installed in an outer protective casing.

Special requirements are no problem

Flooding... contaminants... extra equipment... non-standard casing... security concerns... no room at the wellhead... special fittings for gas monitoring... we handle these situations, and more, before they become problems.

Protected caps have PVC bodies with locking covers, available for wells from 1.25" to 8" diameter. Threaded models and special purpose caps are also available.

Ultra-low clearance, watertight caps are one of our most frequently used specialties, solving problems for well completions below grade in parking lots or other critical areas. Sealing caps and special discharge options are essential to protect well heads subject to flooding.



QED Well Cap Advantages

- Machined for easy installation and removal — even standard caps are lathe-turned to prepare the I.D. for a smooth fit with no jamming.
- Large stock of caps for most MicroPurge and conventional sampling system applications.
- Low clearance caps for tight quarters at the wellhead.
- Watertight caps protect wells with below-grade closures.
- Numerous configurations allow the widest range of auxiliary equipment and discharge options.
- Custom caps with quick turn-around — to match your well casing, closure, and downwell equipment needs on schedule.

WELL CAP SPECIFICATIONS

Cap Configuration	*Sample Pump	†Sample & Purge Pumps
Standard Cap Sizes	2", 4", 5", 6" (5.10, 12.5, 15 cm)	2", 4", 5", 6" (5, 10, 12.5, 15 cm)
Locking/Sealing	2", 4"	4"
Cap Sizes	(5 cm, 10 cm)	(10 cm)
Low Clearance	2", 4"	4"
Cap Sizes	(5 cm, 10 cm)	(10 cm)
Low Clearance	2", 4"	—
Locking Cap Sizes	(5 cm, 10 cm)	—

* Tube fitting sizes available: 1/4" & 1/4" (6 & 6 mm); 1/4" & 3/8" (6 & 9 mm); 1/4" & 1/2" (6 & 13 mm)

† Tube fitting sizes: 1/4" & 1/2" (6 & 13 mm) plus 1/2" & 3/4" (13 & 19 mm)

Cap Options

MicroPurge Flexible Discharge Adapters

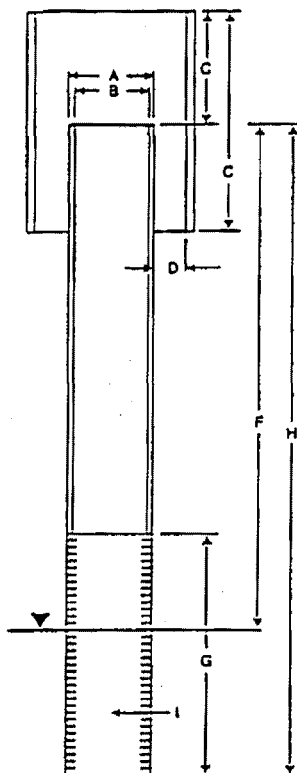
High Pressure Cap Adapter (fitting compatible with high pressure controller air supply hose).

High Pressure to Standard Adapter (adapts high pressure controller air supply hose to fit standard cap fittings).

Ultra High Pressure Cap Adapter (fitting compatible with ultra high pressure controller air supply hose).

Marine Quality Padlocks (keyed alike).

All standard caps are ready for use with Purge Miser packers.



Standard Casing Dimensions:

Nominal Pipe Sizes (inches)	Schedule 40 O.D.	Schedule 40 I.D.	Schedule 80 O.D.	Schedule 80 I.D.
2	2.375	2.049	2.375	1.913
2 1/2	2.875	2.445	2.875	2.289
3	3.500	3.042	3.500	2.846
3 1/2	4.000	3.520	4.000	3.326
4	4.500	3.998	4.500	3.786
5	5.563	5.017	5.563	4.767
6	6.625	6.031	6.625	5.709

Sampling System Design Data

Site: _____

Location: _____

Date: _____ Well Purge Volumes Required: _____

☐ MicroPurge low-flow sampling system required

Sampling Parameters (Metals, Low Level Organics, etc.): _____

Well Bottom to Pump Intake Distance: _____

Casing Material: _____

Pump Material Preference: _____

Pump Tubing Material Preference: _____

Optional Cost Analysis Information

Current Sampling Method: _____

Frequency of Events (Quarterly, Yearly, etc.): _____

No. of Persons in Sampling Crew: _____

Man Hours to Purge, Sample and Clean: _____

Hourly Labor Rate Assumed: _____

No. of Cleaning Banks per Event: _____ Blank Cost: _____

WELL I.D. NUMBER

A. Well Casing Diameter — O.D.					
B. Well Casing Diameter — I.D.					
C. Clearance from Top of Well Casing to Top of Outer Casing/Vault					
D. Clearance of Outer Casing/Vault to Well Casing					
E. Outer Casing/Vault Depth					
F. Depth to Top of Static Water					
G. Screen Length					
H. Depth of Well					
Water Yield (G.P.M.)					



1-800-624-2026

www.micropurge.com

10/11

Attachment 3

Chain of Custody Form

777 New Durham Road
Edison, New Jersey 08817
Phone: (732) 549-3900 Fax: (732) 549-3679

PAGE OF

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Water Metals Filtered (Yes/No)?

Relinquished by	Company	Date / Time	Received by	Company
1)			1)	
Relinquished by	Company	Date / Time	Received by	Company
2)			2)	
Relinquished by	Company	Date / Time	Received by	Company
3)			3)	
Relinquished by	Company	Date / Time	Received by	Company
4)			4)	

Laboratory Certifications: New Jersey (12028), New York (11452), Pennsylvania (68-522), Connecticut (PH-0200), Rhode Island (132).

Attachment 4

Laboratory Bottle Label

STL EDISON
a division of Severn Trent Laboratories, Inc.
777 NEW DURHAM ROAD
EDISON, NJ 08817
(732) 549-3900

PROJECT NAME/CLIENT

SAMPLE LOCATION/DESCRIPTION

TEST PARAMETERS

CONTAINER NO.

PRESERVATIVE

DATE

TIME

SAMPLER'S INITIALS

Appendix B

Health and Safety Plan & Hazard Assessment

The proposed scope of work will follow the health and safety procedures outlined in the documents included as appendices to the following reports:

1. Site Health and Safety Plan (RMT, February 1997) – Included as Appendix C in the report entitled Remedial Action Plan Phase I Free Product Recovery (RMT, February 1997).
2. Health and Safety Plan/Hazard Assessment (RMT, October 2000) – Included as Appendices C and D, respectively, in the workplan entitled Further Off-Site Groundwater Investigation at MW19/Hot Spot 1 (RMT, October 2000).

Additional health and safety plans and procedures will be provided as ongoing site work dictates.

Appendix C

Emergency Points of Contact

L.E. Carpenter & Company
170 North Main Street
Wharton, New Jersey

EMERGENCY NOTIFICATION

IN CASE OF AN EMERGENCY, PLEASE CONTACT THE FOLLOWING PARTIES

- ♦ **L.E. Carpenter & Company, On-Site Contact**
Mr. Ken Redcliff; (973) 366-9577 main; (973) 254-0022 pager

- ♦ **RMT, Inc., 222 South Riverside Plaza, Suite 820, Chicago, IL 60606**
Function: Environmental Project Management and Engineering
Project Manager: Mr. Nicholas J. Clevett
(312) 575-0200 Phone
(312) 575-0300 Fax
email: Nicholas.Clevett@rmtinc.com

- ♦ **L.E. Carpenter & Company, 33587 Walker Road, Avon lake, OH, 44012**
Function: Client
Point of Contact: Mr. Cristopher R. Anderson
Position: Director of Environmental Affairs
(440) 930-1334 Phone
(440) 930-3034 Fax

- ♦ **New Jersey Department of Environmental Protection (NJDEP)**
Function: Regulator
Point of Contact: Mrs. Gwen Zervas, Case Manager
(609) 633-7261 Phone
(609) 633-1439 fax

- ♦ **United States Environmental Protection Agency: USEPA Region II**
Function: Regulator
Site Contact: Mr. Steven Cipot, Case Manager
(212) 637-4411 Phone
(212) 637-4429 fax